CALIFORNIA VEGETABLES

WICKSON

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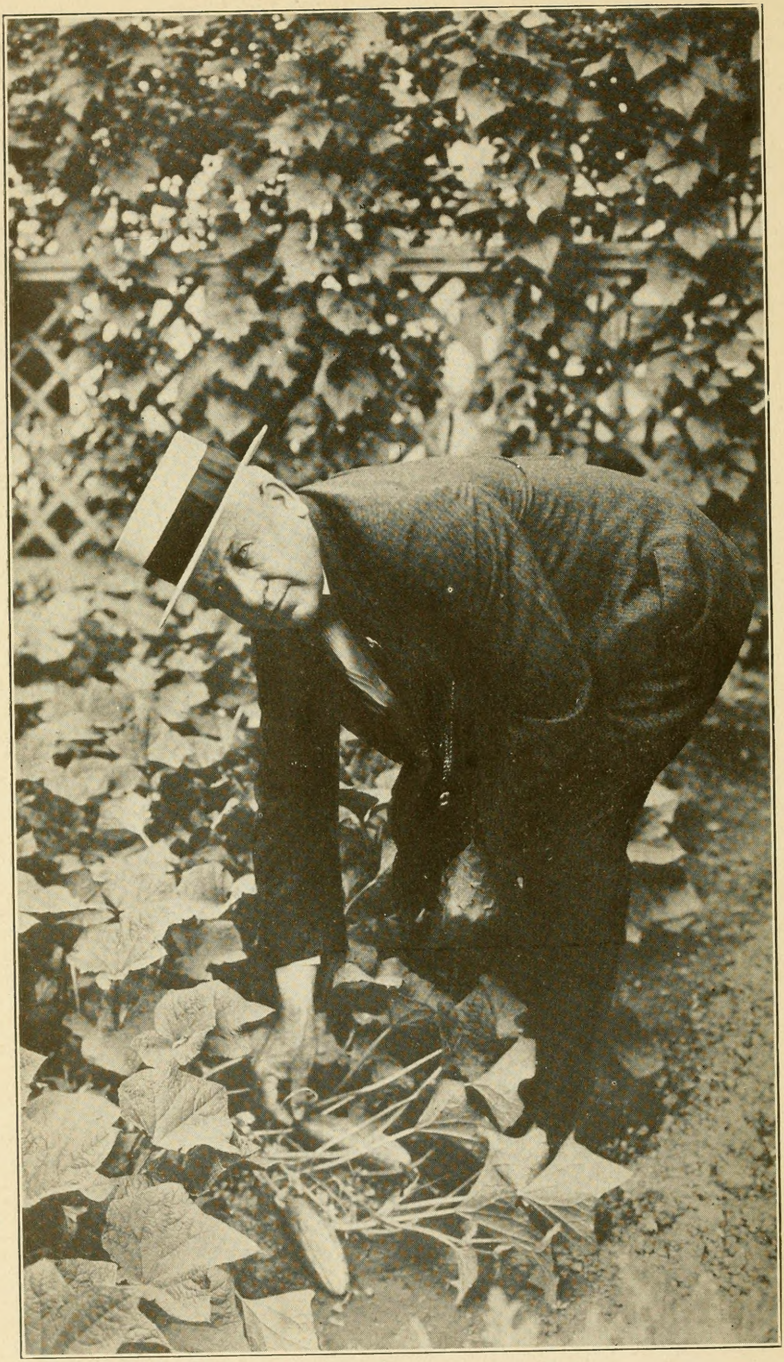

Governor Stephens of California points with proper pride to his cucumbers.

THE
CALIFORNIA VEGETABLES IN GARDEN *and* FIELD

A MANUAL OF PRACTICE WITH AND WITHOUT IRRIGATION FOR SEMI-TROPICAL COUNTRIES

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SAN FRANCISCO

FOURTH EDITION
Revised and Extended

PACIFIC RURAL PRESS
SAN FRANCISCO
1917

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1917

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PREFACE TO FOURTH EDITION

The purpose of the work is to give the newcomer, or old-resident beginner, an understanding of the peculiar gardening conditions which he encounters in California and descriptions of practices which attain most satisfactory results under those conditions. Experienced gardeners from other states and countries soon find that their accustomed procedure fails of its wonted results; that the old times and ways of doing things are unsuitable, and that new rules of practice must be learned. Often those who have had no earlier gardening experience seek a rural home in California and desire to possess a home garden or to engage in commercial production of vegetables. They soon find that following the advice to beginnners given in books written for other climates, yields many disappointments.

In addition to broad differences between California and other areas occupied by English-speaking peoples in the Northern Hemisphere, conditions of soil and climate are very diverse within the boundaries of this commonwealth and gardening practice must vary with them. No matter how skilful and successful a man may be in his particular locality, his experience can only be a safe guide to those who happen to work under similar conditions. Therefore a suggestive treatise must analyze the local conditions and practice and translate them into terms of wide applicability. To do this it is necessary that the principles underlying the successful practice should be discerned and the significance of conditions be interpreted. That this character has been in some degree attained in this work is attested by its acceptance as a guide in all parts of California and by the sphere of popularity and usefulness it has entered in distant countries, which have resemblance to California in climatic conditions and desire to establish similar industries upon them.

The writer has had opportunity for wide collection of data, and for extended personal observation as well, and his effort has been continually inspirited by enthusiastic delight in the subject itself, gained from his own garden work.

In the preparation of this edition, the text has been carefully revised and freshened with the latest information, and the type has been re-set throughout. In a work of this kind, involving the experience and observation of many individuals during a considerable period of time, it is impossible to render a full account of the writer's indebtedness. Wherever direct use has been made of the experience and methods which others have formulated, an attempt has been made to render definite credit to the source. When such accounts of experience are used without citation of publication, credit is, in most cases, due to the columns of the *Pacific Rural Press,* a journal which has been the chief medium for the publication of information of this kind for the last forty-seven years.

EDWARD J. WICKSON.

University of California, Berkeley, October, 1917.

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CHAPTER I.

VEGETABLE GROWING IN CALIFORNIA.

Though California enjoys world-wide fame for fruits it is an interesting fact that the state first won horticultural recognition upon achievements in vegetable growing. Garden seeds were more easily transported than trees and formed a part of the scant baggage of many gold-seekers. Seeds were also freely sent by home friends or quickly obtained on orders to eastern dealers as soon as the agriculturists among the argonauts saw their opportunity in the fabulous rates which esculents commanded. Results, too, were more quickly secured with garden seeds than with fruit trees. Only a few weeks after their planting the grower saw that he was dealing with forcing and developing agencies in climate and soil more effective than any he had known in his old home and he was quite as surprised at his own achievements as his eastern friends were incredulous at his descriptions of them. They were ready to believe anything about gold, because their conception of a gold country involved its traditional right to be fabulous, but such a concession was not to be made to common vegetables. Eastern people knew cabbages and beans and to attribute to them colossal dimensions and to allege that they grew from seed to succotash without a drop of rain was simply coarse lying. It is easy to see why a milder word would be considered inadequate, for the following was one of California's first horticultural proclamations:

> On land owned and cultivated by Mr. James Williams, of Santa Cruz, an onion grew to the enormous weight of twenty-one pounds, and a turnip was grown which equaled exactly in size the top of a flour barrel. On land owned and cultivated by Thomas Fallen, a cabbage grew which measured, while growing, thirteen feet and six inches around its body. The weight is not known. A beet grown by Mr. Isaac Brannan, at San Jose, weighed sixty-three pounds; carrots three feet in length, weighed forty pounds. At Stockton a turnip weighed one hundred pounds, and at a dinner for twelve persons, of a single potato, larger than the size of an ordinary hat, all partook, leaving at least the half untouched.[1]

These statements are vouched for by twelve persons whose names are given. To save the respect of their eastern friends and at the same time to loyally make known the horticultural glory of the land they had found, the early vegetable growers had recourse to public exhibitions. The first was held in the fall of 1851 in San Francisco. The exhibits did not quite equal the verdict of the horticultural jury cited above but they were notable, e. g.: a red beet from San Jose, twenty-eight inches in circumference, weight forty-seven pounds; beets two months from seed in San Francisco, six and seven pounds; cabbage from Mission San Jose seven feet in circumference, weight fifty-six pounds; cucumbers eighteen inches in length; onions five, six and seven inches in diameter from a product of nearly seventy thousand pounds to the acre; potatoes from Santa Cruz, one hundred and twenty-five pounds from the five vines of a single hill and one potato from Santa Clara thirteen inches in length, weighing seven and a quarter pounds; pumpkins and squashes from one hundred to one hundred and forty pounds each.

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[1] Rep. of the Com. of Patents for 1851: Part II, p. 4.

The demonstrations furnished by such public exhibitions, of which there were several in the early years of San Francisco, were accepted at the East, and even such conservative experts as the late Dr. Warder of Ohio were led to exclaim, as early as 1852, "truly this is a wonderful country."[2] To fully appreciate the significance of the facts it must be remembered that the varieties were those of nearly half a century ago and the culture was wholly lacking in the intensive arts which are common property of vegetable growers of the present day. The immensity of the specimens and of the crop, wonderful to the grower and incredible to the distant hearer, was simply the exponent of the capacity of a virgin soil, in which fertility had been accumulating for ages, and the forcing power of a climate wholly new to Americans. In later years California has surpassed even these early standards through the employment of higher horticultural skill, as will be described presently, but it was upon the achievements of the vegetable growers at the very beginning of the American occupation that California's horticultural reputation was established.

How the Pioneers Prospered by Vegetable Growing.—It would be easy to collect quite a volume of interesting instances of how success was attained in the early days, but a single experience must suffice. It illustrates both the resources of the pioneers and the country which they found. G. G. Briggs left New York state in April, 1849, and arrived in California in October of the same year, driving an ox team and walking most of the way. He says:

> When I arrived in California I saw at once that there were other means of accumulating gold besides digging it from the mines; that miners and all classes would need turnips and cabbage and other products of the soil; that even then many were suffering with scurvy and other diseases for the want of fresh vegetable food. The large crops of native grapes on the banks of the Sacramento were proof of the productive capacity of the California soil and climate. Reaching Sacramento, our party of four had no money and no property but our wagon and three yoke of oxen. I could find no work whatever. I got trusted by a storekeeper for a sack of walnuts and sold them to passers by the teacupfull and in five days cleared fifty dollars. We sold our oxen and with my part of the money I went to San Francisco to buy garden seeds with which to start vegetable growing on a piece of land I had seen previously in the bottom of the Yuba river, near the present site of Marysville. As it was too early in the season to plant, I bought a whale-boat and began freighting

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[2] Western Hort. Review, Feb., 1852.

> goods; and by spring I had accumulated about three thousand dollars. The last load freighted by me included a ton of potatoes, which cost me forty cents a pound. My seeds and potatoes were planted in March, 1851, and everything was doing well until cut to the ground by frost on April 19. My potatoes, however, came up again and made a fair crop. I was not to be cheated out of my vegetable crop, and started out again to buy seeds, but could find none, either in Sacramento or in San Francisco. Returning to Sacramento, I chanced upon some watermelon seeds on the boat, and bought the lot for twenty dollars. With these I planted five acres, and cleaned up about five thousand dollars for one summer's work. The next year I planted about twenty-six acres of watermelons, and in the fall I found I had twenty thousand dollars for my summer's work.[3]

With the money Mr. Briggs returned to New York for his family and brought also, on his return, some fruit trees, and laid the foundation of his subsequent brilliant record as a pioneer fruit grower. Others followed about the same course and thus vegetable growing became not only the basis of California's horticultural reputation but actually furnished the capital for the ventures which demonstrated the possibility of our great fruit industries.

Vegetables at the Missions and the Ranchos.—The American pioneers found little at the establishments of the old regime that was instructive or even suggestive. In fact, the Spanish conception of the agricultural capacity and adaptability of the country was not only inadequate; it was erroneous as well. Though the missions had gardens, they were almost destitute of gardening as we understand the term and whether the Spanish and Mexican settlers were deterred from vegetable growing by their distaste for any physical exertion, away from the saddle, or by their ignorance of the fitness of the country, is not a question of much importance in this connection. Hittell says: "Gardening was not attempted except on a very small scale and only for such vegetables as could be produced with very little labor. . . . Potatoes and turnips were rare and of garden vegetables in general it my be said that until the advent of foreign settlers they were scarcely cultivated."[4] Bryant, who visited California in 1846 and examined the Los Angeles gardens, saw only onions, potatoes, red peppers and beans and added that he believed other vegetables would grow as well as they.

Illustrating the inability of the rancheros to understand the wide applicability of the simple horticultural lessons given at the missions, it is related that at the time of the American settlement most of the Spanish families living in different parts of Alameda and Contra Costa had their garden patches near the Mission San Jose. They knew fruit and vegetables would grow there, because they had seen them in the mission gardens and they did not know they would grow elsewhere and had not taken the trouble to find out. Thus the Estudillos of San Leandro had their garden patch at the Mission San Jose and transported their vegetables fifteen or twenty miles, while right outside the door of their house at San Leandro was the finest garden soil in the world, and they did not know it![5]

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[3] Condensed from narrative of G. G. Briggs, in Rep. State Ag'l Soc. 1881. Another account (Rep. 1858) says this watermelon crop was grown by Mr. Briggs with the aid of two men.

[4] Hist. of California, Vol. II, p. 474.

Neither the mission gardeners nor their rancheros had any idea of the capacity of the country for summer crops without irrigation and without any adequate conception of the offices of cultivation they could hardly have attained it. Hence, not having the irrigation facilities which were developed at the missions, and not being inclined to any labor by which their own lands could be irrigated, they would naturally go to the water rather than attempt to bring the water to their land for anything more than stock and domestic uses. Almost at sight the American pioneer horticulturists discerned possibilities and adaptations in the soil and climate which their predecessors had not discovered during seventy-five years of occupation. The relations of race to horticultural progress are very interesting.

Vicissitudes of Early Vegetable Growing.—Those who first discerned the fact that it was easier to get gold with the hoe than with the pick, realized market prices as surprisingly great as the vegetables they grew. John M. Horner, of Alameda County, is reported to have cleared about $150,000 from his large venture of eight hundred acres in vegetable growing in 1851, and others gained much more per acre than he, with smaller operations which did not require so much high-priced labor. But the demonstration of their success proved its destruction. Plantations were made out of all proportion to requirements and disastrous overproduction speedily ensued. The second year after the exhibition in San Francisco, to which allusion has been made, there was a collapse. The following account of potato growing shows how sharp was the turn of affairs:

> In 1852 Beard & Horner's potato crop at Alvarado averaged 200 sacks (about twelve tons) to the acre, and sold for upwards of $100,000. The following year everybody cultivated them. In Pajaro valley 20,000 sacks were one day bet on a horse-race. Beard & Horner contracted theirs in advance at two and a half cents a pound to San Francisco merchants. Garrison took one million pounds, which were never removed, but were allowed to rot on the ground. Saunders & Co. purchased a large quantity, which they stowed away in a hulk in the bay. As warm weather came on the potatoes commenced growing and threatened to burst the vessel open. They commenced dumping the potatoes into the bay, but the harbor master stopped it, and the owners had to pay for their removal to another locality.[6]

With the first disaster the charm and spirit of pioneer vegetable growing passed away. There was, of course, quick recovery in values and very profitable business done, but it was not the same grand affair and it did not accord with the adventurous spirit of the day. Small growers near the cities and the mining camps did well, but there was not dash enough about market gardening for

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[5] Interview with Hon. J. L. Beard, in Oakland Enquirer, May 15, 1897.

[6] Centennial Year Book of Alameda County, p. 483.

Americans and it was soon given over to immigrants from the south of Europe and China and has never been recovered. Field growth of staple vegetables on a large scale has been continued by Americans, but even in this line he has often been obliged to withdraw from competition with Chinese, Portuguese and Italians with their cheaper labor supply and living expenses. Great enterprises in live stock, wheat, wool and fruit afforded opportunities more to the American taste than vegetable growing. The American settler had incomparably more energy and industrial ambition than his predecessors, the Mexicans, but he shared with them a liking for doing his work in the saddle or on the seat of a riding plow, cultivator or harvester. Within a decade from the date of the American demonstration of the unique fitness of California for vegetable growing there arose occasion for frequent exhortations to California farmers to restore the garden to its proper place in farm plan and policy, and yet California farmers neglected to supply their own tables and the proper adornment of their house yards until the ranch home in this land of beauty and grand horticultural opportunities became a by-word for unthrift and desolation. Some aspects of this matter will be presented in a following chapter.

Competition with Foreigners.—One of the difficulties of the present situation is that while the American-born Californian has decried vegetable growing, the immigrants from southern Europe, China and Japan have strongly entrenched themselves in it. Now the competition which the American grower has to encounter is depressing and discouraging. And yet the situation is not at all hopeless. The foreigners are not, as a rule, progressive. They are frugal and industrious to an extreme and they undertake a great deal to please their customers with variety as well as low prices. In some points the American competitor can learn from them to advantage. But it is quite easy to surpass them in quality by constant effort for improved varieties, which they are slow to introduce, and to cheapen production by the use of horse labor and improved tools, while they plod along with hand methods and appliances—although it is only fair to admit that the Japanese are more progressive and ambitious of leadership and proprietorship and therefore more formidable rivals. However, if the California farmer should put forth the same effort to adapt conditions to ends and to keep himself at the very front in materials and arts of production in the growing and selling of vegetables that he has employed in the growing and selling of fruit, we should hear far less of the superiority of the foreigner in the vegetable garden.

There have arisen during the last few years quite notable instances of the truth of this claim, and almost everywhere in the vicinity of towns some market gardens by Americans can be found. The situation is well portrayed in the following paragraph from an address at a Farmers' Institute by S. J. Murdock, one of the most successful early vegetable growers of southern California:

> The business of growing vegetables has grown step by step, until at present it is a great industry, mostly in the hands of Asiatics. Yet in some places white men are getting a share of the trade, and if they would combine and exchange vegetables, as the Chinamen do, they would soon have the bulk of the business. The people of California know no seasons for the different vegetables, as they do at the East. They demand beets, lettuce, onions, turnips, radishes and cabbage the year round, and they want asparagus, peas, parsnips, salsify and cauliflower nearly all the time. White men should combine and exchange different kinds, for one man can hardly succeed in having all varieties in the proper quantities, as different soils and locations produce different results. But the average Californian does not take kindly to the business. He considers it "puttering" work. Yet it is far ahead of wheat raising. It takes study, and lots of it, to keep abreast of the times, for we cannot raise the vegetables of ten or twenty years ago and make a success of the business. There has been as great improvement in vegetables as in other things. There is scarcely a region in southern California where an industrious, energetic man could not work up a trade along this line. He should not expect to make a fortune in a few years, but after the first few months he would have a steady income, increasing from time to time, as he learned the wants of his customers and catered to them.

Recent Achievements in Vegetable Growing.—Although California horticulturists as a class are charged with neglect of vegetable growing, prizes awarded to California growers by eastern seedsmen in competitions open to the whole country show indisputably the eminence of California, and are the more valuable because the weights are certified by the judges in these contests. From our records in this line we select a few, as follows:

Varieties	Weight
Silver King Onion, single specimen	4 lbs. 9 oz.
Jumbo Mangel " "	91 lbs.
Imp. Sugar Beet " "	35½ lbs.
Wethersfield Onion, yield acre	66,905 lbs.
Jumbo Mangel, single specimen	39 lbs.
Prizetaker Onion " "	6 lbs. 2 oz.
Jumbo Watermelon " "	131¼ lbs.
Prizetaker Onion, yield 1 oz. seed	8384 lbs.
Silver Skin Onion, largest	4 lbs. 2 oz.
Mammoth Pompeii Onion	4 lbs. 8 oz.
Red Victoria Onion	4 lbs. 12 oz.
Giant Intermediate Mangel	32 lbs.
Burpee's Bush Lima Bean, 1 plant	323 pods
White Victoria Onion	5 lbs. 6½ oz.
Great Divide Potatoes, from 1 lb.	542 lbs.
Gibraltar Onion	1 lb. 15 oz.
Genuine Mammoth Pumpkin	187 lbs.
Henderson Bush Lima Bean, 1 plant	294 pods
Marblehead Mammoth Cabbage	81 lbs.
Warren Cabbage	77 lbs.

Vegetables for Distant Shipment.—A new phase of the vegetable-growing industry of the state arose with the openings of the overland railways, but it developed very slowly and it was at first marked by great uncertainty in values, causing losses as notable as profits to those in the shipping trade. The railway freight rate has been the ruling factor, though the destruction of eastern crops through unfavorable weather conditions has sometimes opened opportunities for shipment from California in spite of charges which were at other times prohibitory. The eastern demand for some kinds of vegetables has, however, led to the production of several important vegetable crops in very large volume and has thus given us specialty farming in vegetable lines somewhat comparable with our great fruit specialties. When this has occurred vegetable growing has seemed worthy of American effort and our people have been proud to undertake production by the car-load or train-load of the very crops which they would scorn to think of growing by the wagon-load. The features of this line of production will appear in connection with the discussion of the special kinds of vegetables which are involved in it.

An idea of the importance of vegetable growing for distant sale can be had from the following records of railway shipments of fresh vegetables beyond state lines, in tons of 2000 pounds:

1910	78,829	1914	247,512
1911	130,728	1915	331,941
1912	129,659	1916	351,265
1913	147,277		

In addition to the foregoing there are considerable shipments by sea from the port of San Francisco to Pacific countries—a movement likely to be largely increased by the operation of the Panama Canal.

Vegetable growing for distant shipment is quite different from home or truck gardening. The grower for shipment is a specialist; he grows but few kinds, and often one kind only, and it becomes necessary for him to study the particular kind he raises in all its forms, not only as to selection of variety, but to obtain the very best strain of that variety. He also has to study very closely the most economical methods of planting, cultivation, harvesting and marketing. Local soil, moisture and weather conditions determine what crop to raise. Though we can raise desirable vegetables at some time of the year in the same locality for home use or local sale, the point to consider for shipment is to raise that vegetable which brings the best crop at the right time for shipment.

Canned and Dried Vegetables.—Another form in which our vegetables are reaching distant markets in considerable quantities is the product of the canneries, of which estimates are chiefly based upon the records of Howard C. Rowley, editor of California Fruit News, the figures being numbers of cases, each containing two dozen 2½- and 3-pound cans, or the equivalent in gallon cans:

	1913	1914	1915	1916
Asparagus	723,000	768,800	799,480	990,740
Beans	90,190	77,065	81,905	123,475
Peas	93,870	162,195	188,667	227,120
Tomatoes	1,146,560	1,893,650	1,182,705	2,647,300
Other Vegetables	138,710	126,635	119,525	236,525
Total cases	2,192,330	3,028,345	2,372,282	4,225,160

The group "other vegetables" includes about 25,000 cases each of spinach and squash, 10,000 of pumpkin and 5000 of kraut.

Thus it appears that the product has doubled in four years. A discussion of vegetables from a canner's point of view will be given in a subsequent chapter.

Drying vegetables has been pursued in a small way for a number of years, and was stimulated to great expectations when the Alaska mining interest arose and packing food over mountain trails was involved, but wherever transportation routes are established the superior succulence of fresh and canned vegetables discounts the dried product and the latter has not reached great commercial importance.

Value of California Vegetable Products.—The latest authoritative figures of the acreage and value of the products included in this treatise are those of the U. S. Census of 1909, which are now wholly inadequate. The latest records in the case of individual crops will be given, so far as available, in the chapters severally devoted to them. For a general citation of values, figures are drawn chiefly from the estimates of the California Development Board as published in its report for 1917, viz:

Sugar beet	$ 7,500,000
Potatoes	14,805,000
Potatoes, sweet	960,000
Beans	20,875,000
Onions	4,000,000
Melons	4,000,000
Seeds, etc.	3,000,000
Fresh vegetables	12,000,000
Total	$67,140,000

Diversity in Garden Practice in California.—It is hardly too much to say that California garden practice is an epitome of ancient and modern cultural arts, for we have both survival of very old methods and subterfuges and wider demonstrations of the truth of advanced conceptions of cultural efficacy than can probably be found in any other state. This is not due to any purpose or design on the part of our people. It is merely their notable resources of adaptability and ingenuity brought to bear upon the wide range of conditions involved in our combined winter and summer gardening which concentrates in a single commonwealth all the diversity one might encounter if he were a peripatetic gardener with an itinerary extending from Ireland to Algeria. Nor is this remark intended merely as a reference to the natural diversity of the different parts of the state, because success may require more or less distinct methods in summer and winter in the same region. In short, the California gardener has to know arid-land practice and humid-land practice and call them both into requisition equally or incline toward one or the other as his conditions demand. It takes a man of some depth and breadth to do this and this is the reason why land owners who have brought skilled horticultural practitioners from abroad to develop their properties have experienced so many disappointments. It requires head as well as handicraft to master the situation, as subsequent chapters will suggest.

CHAPTER II.

FARMER'S GARDENS IN CALIFORNIA.

It has already been admitted that there has been, ever since the development of large farming enterprises was seen to be possible in California, an indisposition on the part of our farmers to engage in vegetable growing. Several reasons are urged as explanatory of this very widespread sentiment and some of them may be cited:

First: The proper conduct of a large specialty farm gives no time for gardening—not even for the direction of work upon it—and it is better to buy vegetables than incur the worry of a garden patch.

Second: In small specialty farming on a limited acreage of especially fitted and high-priced land, it is not profitable to set apart land for vegetables when its yield in the special product may pay several times the cost of purchased vegetables.

Third: Success with vegetables in California is very difficult to attain—especially so in certain parts of the state—and a farmer is more apt to lose than to gain by any venture he may make in that line.

Fourth: It is impossible to have a garden without irrigation water, even on lands which with ordinary rainfall will yield cereals and carry productive deciduous fruit trees if they are given good summer cultivation.

How Far Are the Objections Tenable?—It must be granted that there is some force in the demurrer which the California farmer often enters against his indictment for lack of thrift and neglect of opportunities in not undertaking to produce his home supply of fresh, crisp and wholesome vegetables instead of depending upon the stale and wilted goods of the itinerant vendors. It is perfectly conceivable that, under certain conditions, the farmer had better buy food supplies rather than produce them, consequently the general denunciation of the unthrift of the California farmer, which is often indulged in by those who know little of the local situation and conditions, is really unwarranted. California conditions, both in nature and in farm policy, are so varied that criticisms and upbraidings are often misplaced. And yet it is perfectly true that vegetables should be grown on farms in California much more generally and in far greater variety than they have been hitherto. It is not the intention of the writer to urge this improvement upon sentimental considerations nor to claim, as many seem inclined to do, that it is possible to compass it by the fiat method. Too many of our critics seem to hold that all the farmer has to do is to declare that there shall be a garden and one will spring up around his footsteps with ideal succulence, richness and deliciousness. It will be better to attempt to show that there is an opportunity, providing its requirements be duly met, and that there are really fewer difficulties in the way and greater rewards for prompt and intelligent effort than many of our farmers imagine. And this can be shown without elaborate arguments. A more striking demonstration will probably lie in showing to the many the success of the few, in order that they may draw therefrom lessons and exhortations for their own incitement and success. This service will be constantly held in view as this work proceeds.

Essentials to Success in Gardening.—There are three requisites to success in gardening and they may be arranged in alliteration thus, Will, Water, Work. They also stand in the order of their relative importance in California. Without a strong impulse in the will it is vain to expect work and water to do their best. If the will is born of taste, liking, enthusiasm, the task will be delightful and the results grand in every way. Unless one has some joy in the rich, moist earth as it yields its fragrance to the touch of his tools; unless he can glory in the quick, responsive growth of the plant when his culture suits its nature, and unless he find pride and satisfaction in the armful of delicious vegetables which he brings each day to his helpmeet, with the dewdrops of the early morning still sparkling upon their foliage, his gardening will never be an easy task though it may be conscientiously and successfully discharged.

But although it is possible to make a good and profitable garden from a sense of duty and though work will reach its due reward even though one can never bring himself to see that the "primal curse" of the race is really its opportunity, it is a fact that without work there can be no successful gardening in California. Perhaps work is the price of success everywhere; perhaps the aggregate of muscular effort proportional to the result is less in California than elsewhere, but let no one deceive himself that the California garden will make itself. The item of work may be reduced to a minmum by intelligent direction. Insight and observation will teach just when each act should be performed to secure the richest cooperative response from nature's forces, and to miss this advantage will entail a vast amount of unnecessary effort, but the modicum of incisive action must be bestowed. It will appear later, in connection with the discussion of the planting season, that timely work is a prime factor—in fact, the pivot upon which the effort may turn from delight to disappointment. California conditions, though exceedingly generous, are equally exacting—probably more exacting than those of humid climates. It is clear, then, that not only is work essential, but it must be work well directed and maintained.

The third essential is water. By due understanding and employment of the characters of the natural growing season and of the soil in each locality, it is possible to produce a great wealth and variety of vegetables in most parts of the state without irrigation. In some parts succession or rotation can be carried through the year by the most intelligent cultivation to prevent evaporation or by the use of land naturally and continuously moistened by underflow. Still, the far greater area of the state will not give satisfactory vegetable supply without additions to rainfall and the irrigated garden should therefore be the end in view in most of our farm planning. Fortunately this is not nearly so difficult to attain as is commonly thought, as will be shown in a later chapter, and if the farm-architect have the will to work, he will not long lack the water to insure the perfection of his desires in his home garden.

Possible Exceptions.—These faint suggestions of the requirements of success in gardening, even on the narrow, farm plan, may intimate that broadside exhortations to vegetable growing are not wise and they may also shed some light upon the reasonableness of those who claim that they cannot profitably or successfully undertake it. Our great specialty farmers are apt to have their heads and hands too full to think of personally mastering gardening practice in a peculiar country. The attempts which have been made to transform the ordinary farm hand into a gardener have usually only yielded disappointment, and the professional gardeners who are really worthy of the name find it too easy to acquire enterprises of their own to warrant their wage-earning on the farm basis. It might as well be conceded at once that many large farmers will do better to purchase their supply from some man who has the knowledge and the soil and water facilities for successful production.

It is also true that in many cases the small scale specialty farmer, working a small tract of high-priced land for a high-value product, does well to plant his entire holding, except his house site, to this product. But it is also true that other men of this class will find the reservation of a garden area a most profitable proceeding. What each shall do depends upon his personal traits and tastes.

But though these exceptions exist and should be considered in any claims that are made in favor of much wider enlistment of California farmers in gardening for the production, at least, of home supplies, the fact remains that farm gardens should be multiplied and that, with proper spirit and effort and appreciation of their value, they can be more easily secured than the popular impression among California farmers would indicate. There is a wealth of experience to show where good timely work is done, under conditions either naturally favorable or rendered favorable by moderate effort or investment, very gratifying results have been attained on farms in all parts of California.

Benefits of Farm Gardens.—It is trite to build arguments on this theme, but the points can hardly be sharpened by comment.

The dietetic benefit of vegetable food in variety has been demonstrated both by individual experience and by the food studies which are now being systematically pursued both in this country and Europe. Working force, thinking force, the quality of success in all lines of human effort, are all promoted by a generous, well-balanced food supply.

The hygienic benefit of food, including due amount of the succulent, aromatic, tonic and assimilable characters which are inherent in fresh and well-grown vegetables, is universally recognized by authorities. The truth has particular force in a region of high temperatures like California. The so-called cooling of the blood, the development of resistance to malaria, the free and healthful operation of the various functions of the body, are unquestionably promoted by vegetable food.

The economic benefit of home-grown esculents has been most clearly discerned during the last few years and the result is a gratifying increase of interest in farm gardening. More vegetables have been grown recently on California farms than ever before. The low market values of some of our most important special products have given an impetus to diversification of crops which a century of exhortation could not have compassed. California farmers have recognized as never before that sound farm policy generally requires the home production of most food supplies. Those who have endured with least hardship financial stress of beginning a farm enterprise are those who have had least to buy and not those who had most to sell. Many a farm has been saved from the mortgagee by the yield of subsidiary products for home use and for exchange for essential home supplies. In this most important service the vegetable garden has done its full share and has thus commended itself to the attention of many who formerly looked upon the growth of "garden sass" as a sort of ignoble pothering. The farm garden saves money and makes money if it is given adequate thought and generous effort.

This exhortation can be given forceful concreteness by the following actual instance which occurred in one of our warmer coast valleys:

"My garden consists of one acre of good river bottom land, and as a matter of course is under good tilth. Besides what we used at home and gave away, we sold to our neighbors as follows:

Green onions	$16.00	Cauliflower	$ 7.00
Spinach	4.00	Green corn	10.50
Early cabbage	12.00	Squashes	8.00
Lettuce	2.25	Tomatoes	18.00
Beets	3.00		
Turnips	4.00	Total	$84.75

"What can be more profitable? Any farmer can do as well if he will only try. How did we do it? I will tell you. Early in November we planted top onions on one-half acre, and on the other half we planted spinach, beets, lettuce, turnips, and carrots. Our seed beds were made in December, and as soon as the onions were ready to pull we replaced them with cabbages, pulling our onions with regard to such planting, also making room for a succession of early peas and snap beans, and finally cucumbers. Of the last three articles we sold a good quantity, and the product will raise the total amount produced for the season to over $100."

This is not an isolated instance. Anyone can do it who can command the "essentials to success" previously considered, and almost anyone can utterly fail of doing it without them. A hint is given of the succession of crops possible in the California garden. There will be much of that hereafter, and it will also appear that making seed beds for winter-growing vegetables in December is altogether too late. Many vegetables should be edible by that time, from a beginning in August and September.

The social benefit of the farm garden may enter the realm of sentiment but it is none the less true, potent and precious. The farm with a garden is an inexpressibly better home than without it. The garden wins interest; it dispenses content. It awakens home pride and strengthens home love. It has actual educational value in that it directly imparts useful lessons in plant growth and requirements which are applicable to all other farm operations. It has lessons also to quicken the love of the beautiful which, in turn, leads in all phases of home improvement and lifts the standard of rural manhood and womanhood.

Of Especial Applicability to California.—All these benefits of the installation of a garden area on the farm should be especially striven for in California because they can be realized here in exceptional measure. The well-planned California garden is evergreen. It admits of succession and rotation within the year, so that a twelve month is the producing equivalent of twice or thrice its duration in wintry climates. Here the garden does not insist upon intruding its claims just in the "rush of spring work" which is known in lands of more marked seasonal transitions. It is well content to be "ahead of the rush" the whole year round, but it must be admitted that it stubbornly rebels against being behind it. Not only is succession of tender growths made possible by the long frostless term, but more than half of the common garden vegetables are so hardy that they maintain growth even through our short frosty season and, with irrigation on lands which need it, thrive the whole year in the open air. Rich is the endowment which a semi-tropical climate bestows upon the gardener. He who does not avail himself of it for his own comfort and profit buries his talent into the earth.

The Garden in Mixed Farming.—During the last few years, aside from the greater interest in vegetable growing on the part of the settlers, which has been noted, there has been a decided gain through the efforts of newer residents to make their smaller holdings self-supplying and income-yielding, as well, by due attention to vegetable growing. All through the state, but especially in southern California, the interest has quickened and the accomplishment has shown that the old idea that only special, narrow areas were suited to garden locations was a misconception. Instances are ample to show not only that proper practice brings ample success almost everywhere, but such practice, coupled with intelligent planning, yields such variety of delicious esculents as only a semi-tropical climate allows. This is one of the distinctive advantages of California and it favors the development of small farms of mixed husbandry as well as those devoted to specialties. Of course there are limitations and locations should be selected with discrimination for either mixed or special farming. The mixed farm in an ever-growing climate makes requirements it is true, but it also bestows compensations. As the forces ministering to growth are continuously active, the full use of them bespeaks corresponding activity on the part of man. There must be a determination to make almost every moment tell in some useful effort. There will be play for the sharpest ingenuity in devising means and methods for time-saving and ceaseless study to make the soil bear the burden of the table to the fullest degree. Small farming requires genius, devotion, and a spirit of content. Its work, when one acquires or is born with a liking for it, is full of cheer and enjoyment. Its varied nature is itself a charm. The trees, vines, plants, and domestic animals will rise almost to the plane of companionship. Man, wife and children will join in the spirit of the enterprise they are carrying on with united heart and hand, and love for home will grow and blossom forth as it seldom does in mansions or on princely estates. Thus the modest calling has its compensations.

The influence of such home upon the state is most salutary. Sound ideas of economy become prevalent; honor and honesty are qualities which win popular approval. Thus, the state becomes really prosperous and sound at the core. The crowning need of California agriculture is to build up enterprises which will stand alone. We have been leaning too long on the shoulders of bankers and commission merchants and commanders of country stores. Without them it is true much that has been done could not have been accomplished, but it is also true that many losing efforts which have been vainly put forth would never have been attempted, and those who have made these efforts would be the better for it. Who can tell how many would have attained moderate and comfortable successes if they had started without encumbrance on a modest plan instead of wasting time with big schemes whose whole returns have gone to feed hungry mortgages and interest accounts, until failure has swept from them the property which they proudly hoped to possess?

But why intrude this homily? The garden is one of the elements of success in mixed farming. Around it other elements naturally gather. As gleaners and profitable transformers of garden wastes and surpluses into home supplies and garden restoratives, the cow, the pig, and the hen await outside the garden fence. Be sure to keep them there, and the garden will be a liberal contributor to their vigor and productiveness.

CHAPTER III.

CALIFORNIA'S CLIMATE AS RELATED TO VEGETABLE GROWING.

It is not necessary to attempt an elaborate exposition of the characters of the California climate. Such characterization has been made by different authorities from various points of view.* It may be claimed in a general way that our climates are as kindly disposed toward vegetable growth as they are toward the development of fruits or the early maturity, thrift and comfort of animals. The ordinary exemption from ground-freezing at any time of the year; the absence or very rare and localized occurrence of soil-shifting winds or even of winds to prostrate tall growths; freedom from wide extremes in temperature; and only occasionally great changes in atmospheric humidity; adequate heat for rapid growth with a dry, but seldom desiccating air, which prevents much of the fungous growth of hot, humid climates and consequently insures a grand and healthy leaf-action to the plant; abundant sunshine, but seldom, and then only in few localities, rising to leaf burning; ample moisture either by rainfall or irrigation, or one supplementing the other—all these characters and others like them, constitute a climate of exceptional advantage to the vegetable grower. They reduce provisions for protection to a minimum; a cloud of smoke for the frost; a high fence or a line of trees for the wind, a lath or slight brush covering or the neighborly shadow of a taller growth for the most tender foliage; frequent cultivation to retain moisture in the soil after rain or irrigation, and the garden will go through the year with ample protection at its weakest points. And all these are not needed in the same locality; in fact, some localities need none of them except the moisture retention which is universal.

Autumnal and Vernal Springtimes.—Spring is defined as "the one of the four seasons when plants begin to grow," and California is fortunate in doubling the blessings of springtime which most parts of the world enjoy. First there is the autumnal springtime which follows the heat in the interior valleys, bringing a delicious coolness to the early morning and crystal clearness to the atmosphere which reveals the distant mountain tops with a sharpness which their outlines do not often reveal through the haze of summer. There is also the autumnal springtime in the coast regions, which brings a little higher heat because the arrest of ocean winds gives the declining sun opportunity to warm the earth as even the vertical sun of midsummer could not do because of the screen of summer fogs which the landward winds interposed. These two manifestations, differing in effects upon the coast and in the interior, are simply phases of one seasonal change and mark the approach of the autumnal springtime in California, the beginning of a new growing season, the advent of another crop-year—reminding the California ruralist of new duties and announcing new opportunities to one who understands the superlative advantage in California of beginning early and keeping everlastingly at it to get the most from the land and from his own labor.

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*Consult "California Fruits and How to Grow Them," Chapters 1 and 2, "California Garden Flowers," Chapter 2.

Of course, California has also the delights of the true vernal springtime, marked by the change from the short, dark days of the rainy season, to the more abundant light and heat of the drier months; a season of blossoms and flowers and of activity of the tenderer plants, when the "rare days of June" appear in the California March and April. Of the two California springtimes which attend the equinoxes, the one of September is the greater in agricultural and horticultural signficance because it is really the beginnning of the crop-year and because timely work then gives success with plants which make their returns during the winter and, besides that, it insures the best results with other plants which yield their rewards in the dry season which lies beyond. The delicious September weather with us is not, therefore, an outholding of cheer to encourage one to endure an approaching winter but a foretaste of the delights of a rainy season which, except during actual storms, is a time of plowing and sowing, planting and pruning and of other fundamental operations which underlie the success of the year. The March springtime, on the other hand, opens the way to the haste of haying and harvest, the distress of late plantings in high heat for which they have no proper rooting, unless the grower comes to their relief with cultivation as their needs require. The September springtime looks to a beginning and the March springtime to a finish of the year—so far as a finish can come to a year which is action from end to end.

Geographical Distribution of Production.—According to the United States census of 1910 the plants generally classified as vegetables, and which are included in this treatise, yielded value to the grower of half a million or more in ten California counties, as follows:

Alameda	$ 841,885	San Joaquin	$2,683,277*
Contra Costa	1,230,155*	San Luis Obispo ..	659,137
Los Angeles	1,473,521	Santa Barbara	1,114,113
Orange	1,194,627	Santa Clara	715,730
Sacramento	914,374*	Ventura	2,773,687

Of the foregoing counties seven are in coast valleys and three (marked *) are interior valley lowlands, so far as their vegetable products are involved. Some of them are contiguous; some of them five hundred miles apart. This demonstrates the breadth of California's adaptation to great commercial production of vegetables.

LOCAL VARIATIONS IN CLIMATE.

Although it is possible to grow almost all vegetables everywhere in the state by intelligently selecting the proper time of the year for each, which will be shown later, and although a few localities have climates so uniform and equable that by providing proper moisture conditions nearly all vegetables can be grown all the year, it is still possible to define regions with somewhat distinctive climatic characters bearing upon garden and field growth of edible plants.

Coast Valleys.—The greatest volume of vegetable products of California is at present grown in the coast valleys. This term includes both well-defined valleys of greater or less breadth, and stretches of rather flat or gently sloping land, open to ocean influences. It is a region extending the whole length of the state and lying between the highest elevation of the Coast Range and the ocean. In the upper half of the state it is composed chiefly of well-defined valleys somewhat parallel to the coast, but protected by low ranges which modify and mollify ocean influences, insuring higher temperature and more gentle winds than are found directly on the coast. In the southern part of the state the region chiefly consists of broad areas quite open to the ocean but needing no barriers from it because, owing to the trend of the coast, the lower latitude and the greater distance south from the source of the prevailing air currents, the ocean influences are themselves modified before they reach the lands. In all this vast region, then, similar conditions prevail, locally modified, however, enough to create some marked differences in degree, which have been well utilized as the basis of special production. Temperature rises and rainfall decreases as you proceed southward. And yet though these differences may notably localize production, the whole coast region north and south has this in common; it has a more equable and lower temperature and a more generous rainfall than the interior valley at its own latitude; it also has lighter frosts, growing lighter still toward the south until it encloses regions here and there which favoring topography makes practically frostless. Such situations favor all-the-year growth of the tenderest vegetables, and perennial beans and tomato trees are possible.

Interior Lowlands.—The region next in importance in vegetable production comprises the lower lands of the interior valleys. They lie along the two great rivers of the northern and central parts of California—the Sacramento and San Joaquin and their tributaries. These rivers flow from nearly two hundred miles, north and south of their confluence, where they mingle their waters through numerous sloughs until the joint streams pour through a gap in the coast range into San Francisco Bay. The same gap which lets out the waters admits the ocean current of moisture-laden wind and moderates the heat of the entire interior valley, but naturally dispenses most moisture, and coolness over the lowlands which lie just in its course as it rushes northward and southward to displace the air which is rarified by the sun heat on the interior plains of the great valley. These interior lowlands along the lower stretches of the rivers have, then, an interior climate modified by the intrusion from the coast, but this only acts in full measure during June, July and August. It acts, therefore, as a moderator of heat and drought during that period and supplements the supply of aqueous vapor which rises by evaporation from the immense acreage of tule swamps and shallow lakes which surround the tillable lands of the region. Climatic conditions in this large interior area favor the growth of vegetables and its producing capacity is beyond any present commercial use which can be made of it. But though it has a temporary coast modification, as has been stated, it falls back into interior habits when restraint is removed. It has intervals of hot, dry winds which exclude the ocean air-currents from access to the valley and then intense dry heat calls for ample water supply, which, fortunately, however, is easily applied, because at such season the rivers and sloughs are running full and if seepage is not enough, siphons or flood-gates admit water from the high-running rivers, or pumps yield great volumes at little cost. But the interior lowlands have another more grievous trait. As they lie very low they are the scenes of the latest spring and earliest autumn frosts and their season for tender vegetables is shorter than that of the coast, though with their higher heat and copious moisture their mid-season product of these tender crops may out-volume a slower, longer season on the coast. But the earliest and the latest tender vegetables do not come from the interior lowlands.

There are interior lowlands of wonderful producing capacity at considerable distances from the confluence of the two rivers just mentioned. For about three hundred miles the river lands extend both northward and southward, offering an area of moist or easily irrigated land of such fertility and extent that it suggests its own ability to produce vegetables for the whole country. At present hardly an appreciable fraction of one per cent of it is employed in production for which it is best fitted. In the future its lower levels will be the Holland and its upper extensions the Nile valley of California. The farther these lowlands lie from the mouths of the rivers the less they receive of coast influences. This gives the distant lowlands a higher temperature and greater forcing power upon vegetation. The nights are warm as well as the days. Vegetables of prodigious size and acre-crops which tax credulity, are the result of the favoring conditions. But these lands are low and danger of frost makes it necessary to select crops for hardiness during a part of the year.

Interior Plains and Foothills.—Above and away from the lowlands of the rivers and their deltas the interior plains stretch far as the eye can reach, and rise, both on the east and west, into the foothills of the Sierra Nevada and the coast ranges. In southern California somewhat similar regions occur as the lands rise from the coast flats to the mesas and foothills of the high, incurved mountain range. There are similar climatic conditions prevailing through these vast interior regions both north and south. The rainfall is light as compared with the coast until the mountain climate is encountered at varying elevations, when it becomes even greater than on the coast. The mean temperature is higher and, except in certain localities, the frosts cover a shorter period and are less severe. Winter growth of vegetables is widely feasible and plants of less hardihood than those of the lowlands are usually safe. But the rains cease earlier in the spring and heat and drought make irrigation essential long before it is required below. For summer growth of vegetables, except on small areas moistened by underflow from mountain springs or valley cienegas, irrigation must be provided. These are the regions which are most apt to be condemned as unfit for vegetable growing, and it is upon such lands that most failures and disappointments occur. It is true that local climatic conditions here need most radical modification by art of man, but it is here also that prompt and timely work and adequate irrigation, wind protection and partial shade win their greatest victories. There is really no reason why the energetic, enterprising man should hesitate for a moment about undertaking preparation for his home supply of vegetables. Commercial undertakings in vegetable growing may have to be confined to few plants grown just at the right moment, but even a small water supply with ample will and work will give a full variety for the family table.

At certain elevations on the mesas and foothills of the interior valley, sheltered by local topography, are practically frostless regions with ample winter rains where winter growth is so fostered that the earliest vegetables as well as the earliest fruits are produced. Some tender vegetables may be ready for the table on the higher location before it is safe to plant the seed on the lower level. And the two situations may be in full sight of each other. It is a fact that in small valleys of the foothills late and early frosts, sharp and destructive, may be more prevalent than on the lowlands of the broad valley below, while on the slopes above them tender plants may be safe.

Irrigated Desert Valleys.—During the last decade a new region with distinctly different characteristics and capacities has become prominent and has achieved notable development. It includes valleys east of the high mountains of southern California and comprises the extreme southeast area of the state, and is largely the ancient flood plain of the Colorado river, whose deep alluvial soils are now irrigated by waters from the river which originally made them. It is known as the Imperial Valley, and has tributaries, like the Coachella Valley, etc. It is distinctly the earliest region of the state, being wholly excluded from coast influences and having the advantages of vernal heat from its south latitude, which comes so early that it practically banishes winter from the list of the seasons. Such conditions have favored the development of a cantaloup industry which markets its product in all parts of the United States before any other region can enter into competition with it. The growth of winter cabbage is also largely undertaken and other early vegetables and fruits are produced to the extent justified by the market demand. As the season advances, however, its adaptability to the growth of succulents becomes restricted to those which can endure high heat and resist desiccation by desert winds which occasionally prevail.

Mountain Valleys.—Among the mountain peaks and ridges from three thousand feet upward are slopes and valleys which are very productive of vegetables. As elevation increases wintry features become intensified and range of winter growth less and less until in the true "mountain valleys," which lie among the summits of the Sierra Nevada, the winter is a closed season of snow and ice and the garden becomes a summer affair as in the eastern states. Growth, however, during the open season is very rapid and satisfactory, moisture is abundant and irrigation facilities ample in the abundant supplies of snow waters from above, which need, however, to be moderated in temperature before distribution. In this region gardening seasons and practices are more comparable with eastern policies and methods and are not characteristically Californian as the term is usually understood.

GENERAL CHARACTERS OF CALIFORNIA CLIMATE.

The proper conclusion from the foregoing discussion is that each California locality must be separately studied to determine its climatic adaptations for vegetable growing and its season for the best discharge of the various gardening duties. Although, as will appear from time to time all through this treatise, very few general prescriptions such as are popular as "gardening calendars," "work for the month," etc., in regions of less climatic diversity, can be given as a guide to work in this state, still there are some generalizations concerning leading climatic features as related to vegetable growing which may be of assistance to distant readers or newcomers.

Relative Occurrences of Cloudiness and Sunshine in California Regions.—Due proportion of sunlight, warmth and moisture is necessary to produce quick and healthy vegetation. Cloudiness is also an important element, since the presence of clouds screens the earth and diminishes the heat received by vegetation from the direct rays of the sun. So also, acting as a screen, it prevents in a measure the radiation of heat from the earth into space, and this materially tends to modify and reduce the daily range of temperature, so that growing vegetation is not subject to as great cold as would otherwise obtain during the night, nor on the other hand, does it receive the full amount of solar heat by day.

The average percentage of sunshine by seasons, with the average number of actually clear days, is as follows for the stations named, as deduced from the records of the United States Weather Bureau for a number of years:

TABLE OF CLOUDS AND SUNSHINE IN CALIFORNIA.

STATIONS	WINTER		SPRING		SUMMER		AUTUMN	
	Sunshine percentage	Average No. clear days	Sunshine percentage	Average No. clear days	Sunshine percentage	Average No. clear days	Sunshine percentage	Average No. clear days
Eureka	52	12	50	12	72	21	64	33
San Francisco	53	35	57	38	57	29	65	42
Los Angeles	66	49	56	36	69	39	75	54
San Diego	61	37	51	26	54	24	63	38
Red Bluff	55	38	62	42	88	80	78	70
Sacramento	63	39	69	52	93	85	82	68
Keeler	74	60	76	61	88	79	84	74
Fresno	55	31	66	51	93	85	85	65

Many useful deductions may be drawn from the above compilation. It should be borne in mind, however, that the weather conditions most favorable for vegetable growing are in some respects different from those which minister to the perfection of fruits. The fruit tree, with its roots deep in a moist soil, welcomes high heat to mature its fruit. The perfection of the esculent falls far short of the maturity of the plant and lies mainly in the measure and tenderness of foliage, stem, immature fruit or fleshy root. These are usually best attained at a degree of heat less than required for fruit ripening. Again edible plants as compared with trees are shallow-rooting and suffer in a very hot surface soil which a tree escapes by penetration of the subsoil. The growth of winter vegetables is advanced by abundant sunshine during the rainy season; the growth of summer vegetables is promoted by cloud-screen from excessive sun heat, and it is clearly refreshed by a summer fog. Herein, in part at least, lies the explanation why the earliest vegetables come from moderately elevated interior regions (except as already noted for interior irrigated desert valleys) and the main crop of midseason and late vegetables is to be sought in regions whose climate is modified by cool coast winds, which sometimes carry fogs and always temper sun action by their content of insensible aqueous vapor. Some plants are especially responsive to this action of coast breezes. Lima beans on the Ventura coast are sometimes rescued from failure through deficient rainfall by days of cool, misty breezes from the adjacent ocean. The same is true in varying degrees of all vegetation and the fact is often of very great economic importance to California.

Distribution of Rainfall.—The local rainfall throughout the state has, of course, about the same relation to local gardening as it has to other farm work, but it seems hardly necessary to discuss it in this place, because it is possible now to secure the data from different sources. Local observers almost everywhere can furnish the facts. It is, however, pertinent to present a general compilation which fixes approximately the date at which effective rains may be expected in each main division of the state and thus impart a somewhat definite notion of when the natural season of growth will begin. All should be in readiness beforehand to seize upon this opportunity for soil working, if one is to proceed without irrigation, and for the planting of seeds of hardy vegetables which will withstand the local winter temperature and give the earliest readiness for use under the circumstances.

When the First Rains May Be Expected.—The rainfall at San Francisco is very close to the mean between the heavy and light rainfall of the state; hence it represents very largely the whole state. Considering the record of the United States Weather Observer, it is found by Mr. Page that during a twenty-five year period ending in 1895, the average date of first 0.05 of an inch of rainfall occurs by September 17. Considering June 30 as the official end of one season and July 1 the commencement of the next season, the earliest date of 0.05 of an inch of rain is July 8, 1885, and the latest October 27, 1875—that is, from July 1 to October 27, 1875, only 0.05 of an inch of rain fell. As 0.05 of an inch of rain is such a small amount, it has been deemed best to consider that when one-quarter (0.25) of an inch of rain has fallen that date be considered the commencement of the rainy season. Using this, then, as a basis, we find that the rainy season begins on October 8. The earliest date of a quarter of an inch is September 8, 1884, and the latest not until November 23, 1880.

As one-quarter of an inch of rainfall at San Francisco is hardly sufficient to allow of rainfall over the southern portion of the state, a basis of one inch at San Francisco was considered for the southern portion as the commencement of the rains there, and this is found to be November 1. The earliest date of one inch of rain is September 15, 1888, and the latest December 3, 1890.

One inch of rainfall at San Francisco is not sufficient for the interior of the state to allow of good plowing and seeding; hence a total of two inches at San Francisco was considered, and it is found that two inches of rain falls at San Francisco up to November 1; hence that date can be said to be the date of commencement of good plowing.

Five inches is considered to indicate that the rainy season has entered upon full effect, and it is found that five inches does not fall before December 15, and that the earliest date that five inches has fallen is October 21, 1889, and the latest February 5, 1891. In this latter season February was very wet, and the total for the season was seventeen fifty-eight hundredths inches.

To summarize, we have first rains September 17; rainy season begins October 8, and in southern portion of state November 1;

ground moistened for plowing November 13, and rainy season in full effect December 15. Of course, there will be occasionally a year in which a good fall of rain may come earlier and, occasionally also, storms from the southward deeply moisten southern California before the normal storms of northerly origin reach the upper parts of the state. Therefore planters everywhere should always be ready to take advantage of the first deep moistening of the soil to start plants which thrive in our autumn temperatures.

The Occurrence of Frosts in California.—The occurrence of frost in California is, from one point of view, a purely local question. As has already been stated, the frosty and the frostless places are often in sight of each other on the same landscape from the same point of view. It can be even more closely drawn than that. It is sometimes quite as plainly to be seen as the high-water line of a river flood on a sloping meadow. This occurs, of course, in what are termed the thermal belts and is determined by elevation, air currents, outflow levels and several other incidents of local topography. There are often wide variations in these lines from year to year and yet there is steadfastness enough about the phenomena to enable residents to agree among themselves as to what localities are "in the frost" and what are out of it. Upon this decision depends the business risk in planting out beans, peppers, tomatoes, etc., for winter growth, and it is upon such fields that the frost, not always content with the local definition of its limits, draws the dead line which the morning sun brings into such fateful prominence. Of course, the grower is not necessarily content to accept such natural boundaries of the thermal belt. He can materially change it all by frost-fighting, but the discussion of that matter belongs to another chapter.

It is important to know as nearly as possible the beginning and end of the frost free period in each locality, and data to assist in determining this fact are given in the chapter on the Planting Season.

COMMMERCIAL VALUE OF THE CALIFORNIA CLIMATE.

It is a striking fact that winter storage of fresh vegetables is not necessary in California. The mild California winter does not freeze hardy vegetables, consequently they are allowed to grow until the shipping season arrives, as in the case of celery, cabbage, parsnips, salsify, etc., or are gathered, sacked and placed under some cheap shelter from the rains, as in the case of potatoes, beets, carrots, etc. No storage pits or cellars are thought of. In fact, the most direct and cheapest method of loading cars is employed in many instances, for railway spurs are carried right into the center of the celery, cauliflower and cabbage fields, the crates filled and the cars loaded from the ground on which the crops were grown. This not only reduces the cost of handling and eliminates the cost of storage, it enables the grower to supply the winter and spring markets on the Atlantic side, in the Middle West and the great interior plateau, as well as the North Pacific coast territory of the United States and Canada, with vegetables fresh from the soil during many months when they have no fresh products of their own.

No part of the United States, except an adjacent district of Arizona and the south end of Florida, enjoys a winter temperature which makes such a traffic possible, and even those small outside areas which have similar temperature do not have other conditions of growth like those of California. It is evident that in the future development of the western half of the continent of North America and in the unfolding of North Pacific countries generally, California is to be the source of fresh vegetables during the many months of winter which prevail in those northern latitudes. For this traffic California enjoys not only suitable growing conditions, but has also the advantage of nearness and of transportation by water. No matter how great, then, the eastern movement of winter-grown vegetables may become, the northern and northwestern movement, of which California will have a monopoly, will induce additional production to an extent which cannot now be foreseen, although the present traffic in those directions is considerable and profitable.

CHAPTER IV.

VEGETABLE SOILS OF CALIFORNIA.

Soils which favor the most satisfactory growth of vegetables are those which are most easily maintained in a condition of tilth to promote seed germination and rapid establishment of the seedling in sure-growing contact with the soil-substance; soils which facilitate deep-root penetration by the advancing plant so that moisture and plant food shall be rapidly reached, and which have sufficient retentive power and capillarity to maintain adequate moisture within reach of the roots and such amount of natural fertility that the plant may attain the greatest growth in the least time. Soils with these characters have also the most valuable incidental qualities of warmth, to foster vegetable processes; porosity to facilitate the escape of surplus water and the entrance of the air with its constituents which promote root action and modification of the soil substance and absorptive power to readily receive and deeply distribute rainfall or irrigation. These are high requirements, for it is an ideal soil which possesses them all.

Ideal Soils Not Essential.—Fortunately gardening art is amply able to supply natural deficiencies in nearly all respects and, if he is working for high-priced products on a comparatively small area, the vegetable grower can often profitably make considerable expenditure for soil improvement. Market gardeners need no exhortation in this line, but the home gardener should be urged not to despair because of any refractory character in the soil he is obliged to utilize. If he study the subject by the aid of most excellent treatises recently written on the soil and its amelioration he can proceed rationally and accomplish marvels with Will, Work and Water upon almost any soil, from a brick yard to a desert. City people have grown their table supplies on housetops; no ruralist can find a less productive subsoil.

Light Rather Than Heavy Soils.—The characters already cited point clearly to what is commonly designated as a rather light soil as best for vegetable growing. The extreme variations in soils are popularly known as heavy adobe and light sandy soils. Neither are usually counted suitable for garden purposes without treatment to overcome their defects and yet as the terms are used in some California regions, there are very good gardens on both of them. The explanation is that in such localities one has less sand and one less clay than the other. Both are really loams or mixtures of sand and clay; one a clayey loam, the other a loamy sand. Aside from this misapprehension of terms we have, of course, clays (locally called "adobe") which are true enough to the type to bring despair to the

A picturesque river-bank garden irrigated with Chinese pump.—Page 43.

Onions and lettuce in San Fernando Valley. Laying off in long rows for cultivation and irrigation.—Pages 54 and 87.

most patient gardener and we have washes of pure coarse sand on which a shallow-rooting plant could hardly live with a stream of water pouring over beside it. But our shifting sands of the interior plains and our so-called deserts are sandy loams which yield profusely when properly irrigated. For the improvement of defective soils for the farm-garden, suggestions will be given later.

Soils Naturally Excellent.—For field growth of vegetables in California the grower is usually content to proceed upon the natural texture and fertility of his soil, although during recent years the use of fertilizers has notably increased. The crop is chosen to suit the local soil and climate, consequently we have districts becoming famous for special vegetable products as demand for them in considerable quantities is demonstrated. In such districts the soils are rather light and yet ample in richness to endure for some time the drain of continuous cropping in the same line. We have areas of such soils considerably in excess of their present profitable use. They constitute one of our undeveloped resources and are a surety of future advancement.

A very gratifying amount of accurate knowledge of California soils is to be credited to the late Dr. E. W. Hilgard, of the University of California, who gave a lifetime to advanced investigations in soil physics and chemistry. It is from his publications[1] that we shall condense some account of the specific character of those soils which are mostly nearly related to local production of vegetables, leaving out of account the heavy adobe, which is little used for these crops except by gardeners who radically change its physical character.

Prevailing Character of California Soils.—In his interesting contrast of the soils of arid and humid regions, Dr. Hilgard makes some generalizations, which we collate to serve our present purpose.

The character of the soils of the arid regions is predominantly sandy or silty, with but a small portion of clay unless derived directly or indirectly from pre-existing formations of clay or clay shales.

The idea of inherent fertility has been associated so generally with sorts of a more or less clayey character, that the newcomer will frequently be suspicious of the productiveness and desirability of the sandy or silty soils of the arid region that experience has shown to be of the highest type in both respects.

Another point of great importance is that the difference between soil and subsoil, which is so striking and important in regions of abundant rainfall, is largely obliterated in arid climates. Very commonly hardly a perceptible change of tint or texture is found for depths of several feet and material from such depths, when thrown on the surface, is nearly or quite as fertile as the original surface soil. In the case of a cellar dug near Nevada City, the red soil mass excavated from a depth of seven to ten feet was spread over part of a vegetable garden near by and tomatoes, beans and watermelons were planted on it. The gowth was even better than on the parts of the old surface not covered, which had apparently become somewhat exhausted by years of use.

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[1] "Soils: Their Formation, Properties, Composition and Relations to Climate and Plant Growth;" also "Agriculture for Schools of the Pacific Slope," by Hilgard and Osterhout. Published by the Macmillan Co., of New York.

Examination has shown that the percentage of humus or vegetable mold is less in the soils of the arid region, but their humus contains more nitrogen. Thus, probably, on the average not only is the aggregate supply of nitrogen in the soils of the arid region approximately equal to that of humid soils, but its absorption by plants is exceptionally favored by climatic conditions.

As to the minerals which constitute fertility, the soils of the arid region contain nearly fifteen times as much lime, five times as much magnesia, three times as much potash, and about the same amount of phosphoric acid as the soils of the humid regions.

Significance of These Facts.—These leading characteristics of California's horticultural soils are of the highest significance to the vegetable grower because they show that California is rich in soils of ideal excellence for his purposes. They are light soils and therefore easy of cultivation and not disposed to bake on drying; they are deep, consequently well drained and yet absorptive and retentive enough; they are exceptionally rich, consequently extremely productive and durable and they can often be given a new fertile surface by deep turning from the fertility of the greater depths. This was the natural endowment which enabled the pioneer vegetable growers to disturb the horticultural peace of the world in 1849-50. The achievements of later years indicate that with rational treatment the superiority of California soils will endure indefinitely into the future.

The distribution of these desirable soils gives all regions a share in them. Either as residual soils resulting from the decomposition of adjacent rocks, or as transported loams which have been carried greater or less distances by wind, glacial action or other moving force, or as alluvial or sediment soils, deposited by action of flowing streams, every California county has its vegetable soils in ample measure. Such is the diversity of soils within narrow areas in California that it may not take a very large farm to enclose several diverse types, and it is the first duty of the settler to learn their special characters and adaptations and plan his production accordingly.

Alluvial or Sediment Soils.—Though there is marked difference in the origin of our soils which are suitable for vegetable growing, when proper moisture conditions are arranged, it is naturally the alluvial or sediment soils which have hitherto been chiefly used. They have been deposited by recent or ancient water courses and have formerly served as river banks or river and lake bottoms. They have beneath them, generally quite far below, the prevailing soil of the adjacent country. They consist of fine alluvium with seldom any admixture of coarse materials. They are usually very deep and well drained. They occur sometimes at a considerably higher level than existing streams and are sometimes designated as "next to river bottom," while lower levels constitute the "river bottom." In some small valleys they have spread deeply all over the original soil, having been washed in such quantities from adjacent hills, and in larger valleys have spread for considerable distances out upon the plain. These are primarily the fruit lands, but they are also largely used for such vegetables as thrive upon lighter and drier soils. Below are the present river bottoms, usually dark, rich and moist and not subject to baking or cracking, which are *par excellence,* vegetable lands.

Peat Lands.—Another class of alluvial soils is known as peat soils, which consist of mixtures in various proportions of silt and sediment with the debris of centuries' growth of swamp plants which the streams have currently overflowed in flood times or over which they have risen daily as the tide wall has held back their waters. This organic matter from the aquatic plants is in various stages of decomposition, but in the best of lands has been reduced to fineness by cultivation after the floods and tides have been excluded by levees, or by natural barriers interposed by stream or wave action, or by recession of lake waters according as the situation is on the coast or distant interior. This light but very deep and rich soil especially suits some plants and is the basis of some of our export vegetable business, as for instance, asparagus and celery growing. Such soils are, of course, used locally for all esculent plants which thrive upon them and which the market favors. Such lands are in vast area in many parts of the state, from near the ocean to the margins of interior rivers and lakes and waters of inteiror plateaus as well. In the heat of the interior valleys they dry out very rapidly when seepage or overflow from streams and sloughs is cut off by levees. They are non-retentive, owing to the coarseness of their structure, but irrigation is easily accomplished, as will be noted in the proper connection.

IMPROVEMENT OF SOIL TEXTURE FOR GARDENING.

Aside from such treatment of the soil as is designed to increase its fertility, which will be considered in the chapter on fertilizing, it seems fitting in this connection to suggest measures by which the texture of the soil may be improved when necessary. This is important in the farm garden because there may not be anything approaching an ideal garden soil inside the line fences. But this fact should not discourage the home gardener, as has already been intimated.

If one observes the operation of market gardeners or reads any treatise on gardening written for the older countries, he is apt to conclude that the Creator has done little for the modern garden except to furnish a place to put it, because the chief art of gardening seems to consist in using as little of natural soil as possible. This state of affairs has not arisen in California yet, for the reasons shown in the descriptions of our garden soils, and yet we do not mean to suggest that the farm gardener should in all cases expect to reach satisfactory results without due effort for soil improvement on the small area which he expects to yield so much.

Improvement of Adobe Soils.—Our adobes, especially those of the darker hues, are rich and durable. In common with heavy clay soils everywhere they are retentive of moisture. In our arid summers, however, they lose their moisture speedily by evaporation, if untilled, and dry out to a greater depth than lighter soils. They are refractory under tillage and unless caught at just the right moment they are either wax or rock under the plow, and the cultivator will either stick fast or ride over the surface. And yet if one has nothing but adobe he is not as badly off as he might be, because adobe is easily susceptible of improvement. The points to attain are several, but they are inter-related and effort for one measurably helps toward all.

The free used of burned lime, either as it comes from the kiln for builder's use or when air-slaked or water-slaked (hydrated), and applied about the time of the first rains is the first and simplest effort toward breaking up the tenacity of the soil. This should be done no matter what greater efforts are to be undertaken later.

Deep and thorough tillage, taking the soil at just that condition of moisture when it works well with plow and harrow, will be found to progressively improve its tillability by mere action of air and implements. If this is all that can be undertaken at first, do this thoroughly and put in the cultivator after each heavy rain as soon as the proper condition of soil arrives, so as to prevent baking of the surface. For winter growth of vegetables in regions of ample rainfall, use the ridge system, which will be described in a subsequent chapter.

But liming and persistent tillage are only temporizing with adobe and do not accomplish permanent reform. The first rational step is to resort to adequate drainage. Tile drains two and a half or three feet deep and twenty feet apart will do for garden plants. This leaves a clear surface for working over, but, if the expense of tiling is not desired, open ditches will answer, but they restrict cultivation to one direction, waste land, and are expensive in hand work in killing weeds in the ditches. Open ditches, are, however, better than no ditches at all. The effect of drainage is to promote friability, to render the soil tillable earlier and oftener, by the quick removal of surplus water, and to promote seed germination and plant growth.

The aeration of adobe by drainage and tillage accomplishes a considerable improvement, but still more radical reform measures are desirable. The soil particles are naturally too small. They must be separated by interposition of coarser grains. Plow into the soil as much coarse material as possible. Farmyard manure, straw, sand, old plaster, coal ashes, sawdust, almost anything coarse or gritty which will break up the close adherence of the fine clay particles, release the surplus water and let in the air, will produce a marked effect in reducing the hateful baking and cracking, root-tearing and moisture-losing behavior of the adobe. Scrape the corrals, rake up the leaves and fine litter of all kinds, make the adobe garden patch the graveyard for all the rubbish which is suceptible of decay. The farm will be neater and the garden will pay the expense in its easier working and better growth. Do this every year before the rains come and you will rejoice that you had an adobe foundation for the farm garden.

The Improvement of Light, Sandy Soils.—This effort is in some cases more difficult than conquering adobe. It all depends upon the coarseness of the sand and the subsoil upon which it rests. If soil and subsoil are coarse sand or gravel to a considerable depth, some fruit trees may thrive, but shallow rooting plants will fail unless they can finish their growth during the rainy season. Summer growth is impossible because water will flow through their sieve-like structure and carry away plant food with it. With moisture leaching away below and flying away above, and with intense sun heat burning the foliage by direct contact and reflection, such wash soils are indescribably worse than adobe. But this condemation should not be rashly applied. The reference is to soils very coarse in character which have the appearance of washed sand and gravel. Otherwise it may be a soil carried from the surface of the hillsides by the eroding streams, and, if composed of reasonably fine materials, in addition to sand and gravel, should have plenty of plant food for a time at least. The chief difficulty will lie in maintaining moisture for shallow rooting plants. Obviously such soils are best suited for winter growth, for they are "warm and early" when situated out of frosty places.

Sandy soils which are imposed upon clay or hardpan, providing the underlying stratum is not alkaline, furnish very promising garden material, even though the layer be too shallow for the growth of trees. Many fruit growers are struggling to maintain trees on such spots in their orchards when they should forsake the effort and by adequate use of water and manure turn such spots into family gardens. The holding of water near the surface, which is fatal to tree roots, is the opportunity for the growth of most vegetables. Depth of soil which is so strongly insisted upon in treatises on gardening, constitutes a storehouse of moisture and plant food, but it has been abundantly demonstrated that depth is not essential provided the plant is otherwise fed and watered. California gardens proceeding upon rainfall alone, need a deep, retentive soil; the irrigated garden may thrive upon a soil too coarse to be retentive providing it has a tight bottom to hold moisture within reach of shallow rooting plants. Therefore reclaim such sand by providing a home water supply, if not in an irrigated region, and use plenty of well-composted and decayed manure, which will not only feed the plants but will also reform its texture and transform the coarse sand into a rich garden soil, kind in cultivation and prodigious in its yield of succulent vegetables, for sand is best of all materials for free and rapid root development.

The treatment of such soil is directly opposite that prescribed for adobe. All coarse materials must go through composting, which will be described in another chapter. The garden should be cleared of all its own coarse refuse and only fine compost or commercial fertilizers used upon it. Both of these act benignly upon its texture.

CHAPTER V.

GARDEN IRRIGATION.

It has already been intimated that the irrigated garden should be the aim of all who desire to attain the fullest satisfaction in vegetable growing.

What Can Be Done Without Irrigation?—But while it is true that the California gardener must have irrigation to do his best and to give him a solid year of rotations and successions in his garden, due emphasis must be laid upon the fact that in suitable locations the unirrigated garden in California is a greater treasure than at the East. This fact is due to the character of our winter climate, which, as has already been shown in a previous chapter, is actually a growing season for all but the vegetables which will endure no frost. By using to their fullest capacity our six rainy months, by early cultivation and planting, which will be fully explained later, midwinter and spring vegetables can be produced in great variety; and by proper cultivation for the retention of moisture, tender vegetables planted as early in the spring as frost-freedom can be assured, will find in a good soil which has received adequate rainfall, moisture enough stored to carry them to perfection in midsummer and autumn, although not a drop of rain may fall from the sowing of the seed to the gathering of the crop. For this reason owners of fairly deep and retentive soil in regions of ample rainfall can attain splendid results without irrigation, if they will only be alert for prompt work and persistent in summer cultivation.

What can be done in California with the unirrigated garden depends upon conditions existing in each locality. Character and depth of soil, amount of rainfall, degree of heat and percentage of relative humidity in the air, the lay of the land—all these are determining factors, in addition to the dates of frost occurrence which fix the opening and closing of the season for tender plants in the open ground. The significance of variations in these factors, and the regions where they usually occur in widest extremes, have been suggested in previous chapters and the ways to shape garden practice to these local variations will naturally be discussed as we come to describe successful methods with the different vegetables. Therefore let no man conclude that he cannot grow vegetables until he completes his arrangement for irrigation unless he is sure that his winter rainfall is too uncertain to grow even a crop of wheat, for a rainfall that will carry the wheat plant to maturity will also produce quite a variety of garden vegetables with proper practice in early sowing and frequent cultivation.

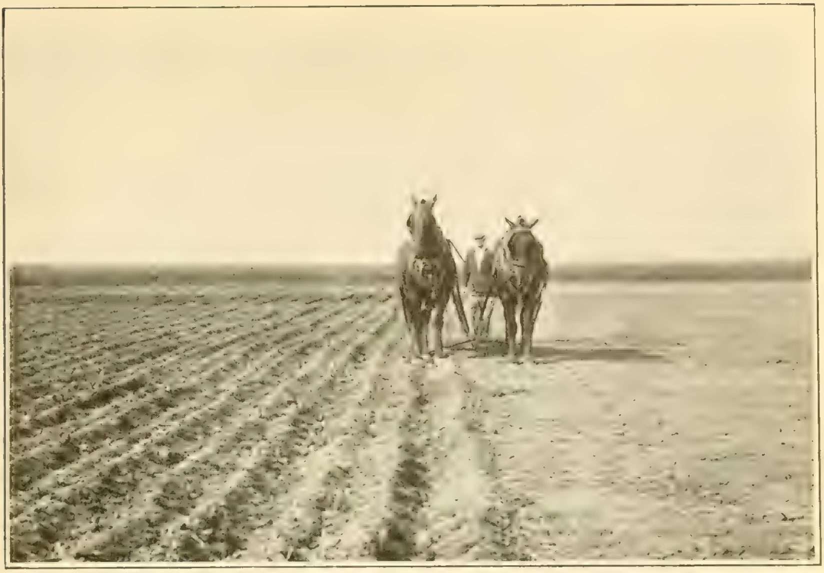
And from this low-water mark the unirrigated garden proceeds upward with richer endowment of favoring local conditions, insuring length of growing season and variety of vegetables until it really becomes a question whether irrigation is needed at all. It certainly is not for ample yield of many, possibly all, of the staples of the garden, but to insure a succession of salads and relishes, potherbs and legumes—in short, to enjoy the fullness of the California season, the irrigated garden, we say again, and for the last time, we hope, is the thing to be diligently striven for.

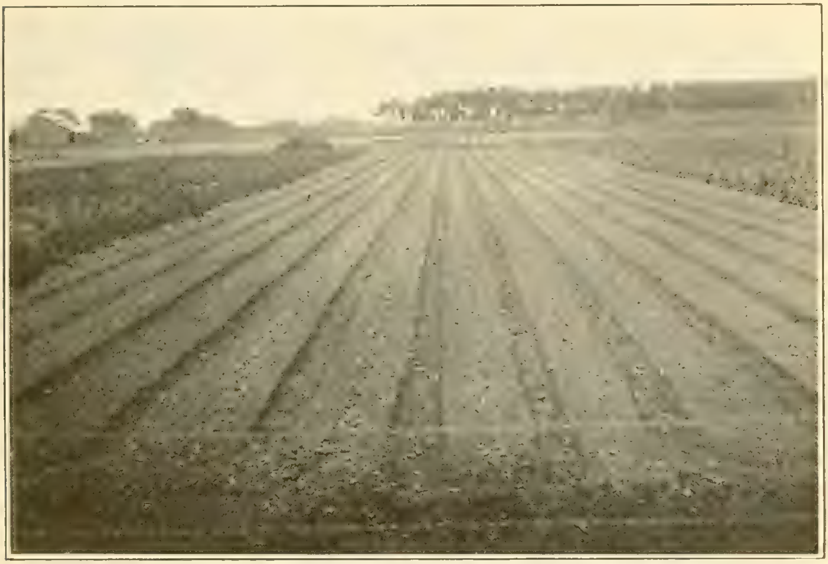
SOURCES OF IRRIGATION WATER.

Whence the garden shall receive its water supply is a question for each to determine according to his environment. Water is now flowing over California gardens from various sources as the result of all sorts of individual, co-operative and corporate efforts and investments. It would require volumes to describe them. Large irrigation enterprises are the joint work of engineers and capitalists. That gardener is fortunate who has only to buy his water from a fair-dealing ditch company or draw his share from a co-operative water company in which he has an interest. Such a source is best of all because causing least labor and expense in average cases. Wherever the landowner can promote honestly and economically managed irrigation enterprises for community use he should do it without an exhortation. But to whatever extent this work is carried there will always remain opportunities, probably, where farm gardens can command their own irrigation supplies at a cost which will warrant the effort. It is in this line that a few suggestions will be offered.

Surface Sources.—In the unirrigated regions of the state there are countless opportunities for home supplies of irrigation water by the simple process of allowing it to run down hill your way instead of that way which is natural to it. Water which would be of great value in the house and barn and farm-garden is allowed to flow by in its own deep channel when a very little use of the level would show that a part of it could be taken out into a ditch or pipe, higher up its course through the farm, and brought along with less fall than it naturally takes, until it reaches the buildings high up the slope above the bank instead of in the deep bed it has cut in the soil below. This is very simple and inexpensive, and yet we have many hillside places in the central and northern parts of the state where the water is carried up by hand to the house, and the animals are driven down to the water, and the garden is neglected because it is too hard work to haul water up to it. Of course, there are many cases where such an obvious resource of the farm has been utilized, but there are many where it is neglected.

Many springs on the hillsides are allowed to be trampled into mudholes by the stock, which need but cleaning out and opening up to yield a water-flow beyond any amount which the old outcrop-





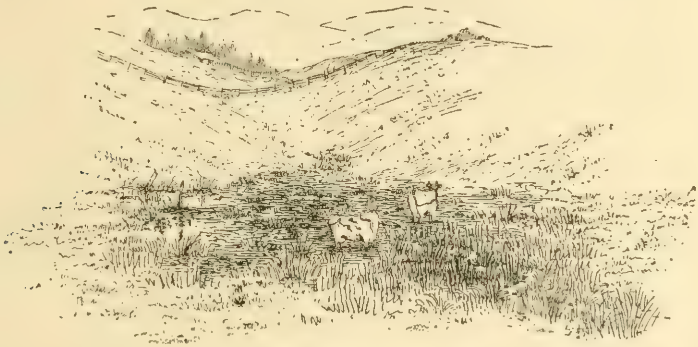
Univ. of Cal. Experiment Station

Laying off in ridges and ridges flattened for planting.—Pages 73 and 202.

Tomatoes, cantaloups, etc., in young orchard.—Page 89.

ping would indicate. A short pipe line would deliver water in the tops of the buildings if desired and would generously irrigate all the land needed for the family garden. And yet the hillsides are full of unused springs. One has, however, to be very careful about handling a spring. Good springs have been lost by excavating or blasting for the purpose of increasing the flow. Sometimes it has caused the spring to disappear entirely. At the same time the flow has been increased on some springs by careful opening, cleaning out interfering dirt and rubbish so as to open the exit of the water without opening other exits for its escape. When this is done, cementing around to prevent loss of water by seepage is often effective in increasing the flow or at least conserving it so that a better run of water is obtained.

Between the hills above the building sites there are many intervales which are impassable in the rainy season and covered with a growth of sedges and swamp grass all summer. They are natural reservoirs of greater or less capacity, holding the surface water and underflow from the hillsides. In the dry season plowing and scraping will easily fashion a small reservoir at the lowest point of the intervale and a pipe line will bring down water at least for irrigation, if it is not suited for other uses. Or if there be below a better site for a reservoir, underdrainage of the swamp will turn it to the growth of good grasses while the outflow from the drains can be converted into garden crops below.



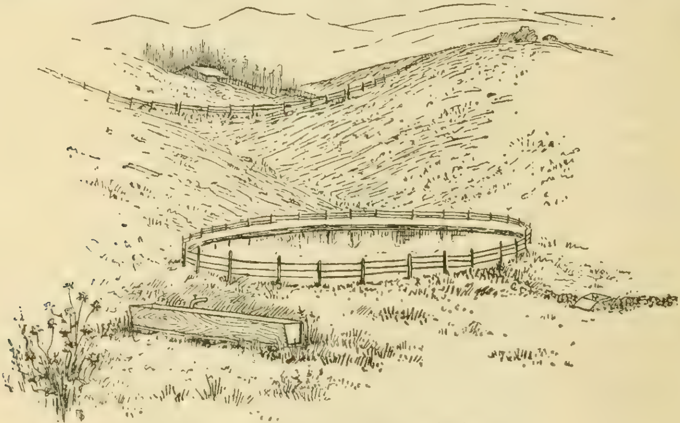
Boggy Land Caused by Seepage.

Again even when the surface after the rainy season shows no sign of moisture, it is often possible to keep a good supply in sight by closing some small vale and dry-creek bed with a dam to hold for summer use in the garden some part of the volumes of water which rush down from the water-shed during the winter rains.

All these are elementary problems in water developing and water saving. It would reflect upon the speaker's intelligence to mention them in some parts of the state, and yet in the unirrigated regions there lie these neglected opportunities—monuments of inattention or unthrift.

Subterranean Water Sources.—There are few places where water for a home garden cannot be had by well-digging and there are many large districts where flowing wells are secured by shallow boring. At the bases of hills horizontal wells or tunnels are frequently satisfactory. The capacity of these wells and tunnels is sometimes very great. They often warrant long-ditch lines or figure in the supply of towns and cities. Unquestionably the present development of water by these means is only a fraction of what is possible and the owner of untried land should undertake a reasonable amount of prospecting. It is, of course, easy to waste money in this way, but if one proceeds after as full study as he can make of the surface, the outcroppings of rock, the experience of others in the same region, he is pretty sure to realize upon reasonable anticipations.

Excavations in dry creek beds of gravel and boulders have often brought to light considerable underflow which has been arrested and the water stored by cement dams resting on the bed rock.



Reclaimed by Reservoir Building.

Flowing wells and wells which bring the water near to the surface constitute the main source of subterranean water employed in California. They have reclaimed large districts which were formerly arid wastes and they are largely used also for summer crops in regions of ample winter rains. Well borers equipped with good appliances are to be found in all parts of the state.

WATER-LIFTING DEVICE.

At this point it will be well to remark that any gardener is fortunate who has water brought to the highest point of his plantation by its own weight without a struggle on his part against the force of gravity, and yet there are thousands of instances of satisfactory home gardening by simple water-lifting devices.

Horizontal Windmills.—Devices based upon the overshot-wheel principle are used to some extent on this coast, but the summer winds at the ground surface are usually too light to operate them well. In its simplest form this windmill consists of four boards, about seven feet long, fastened to long arms projecting from an axle, which has bearings on two strong posts or a framework. The wind only strikes the upper part of the wheel, the lower part being inclosed by a board fence. In a slight breeze the mill revolves about twenty revolutions per minute, but in a good, stiff gale it flies so fast that a sliding board must be raised to shut off the wind. The wheel is connected with the plunger of the pump by means of a crank at one end of the axle.

Gasoline and Crude Oil Engines.—These devices have been greatly improved during the last few years and are now being largely employed for water lifting for irrigation. There are several manufacturers in California, the fuel is very cheap here and this, in connection with ease with which the engines are managed, constitute them most economical and satisfactory agencies for pumping. The manufacturers give full information and can usually cite engines in operation in different localities where their performances can be personally ascertained.

Electric Pumping.—Recently the extension of power lines in nearly all directions in California has made electric energy available for garden pumping and efficient motors at low cost are offered. Handlers of such machinery are always ready to demonstrate the quality and cost of their appliances and they are being widely used.

Steam Engines.—Pumping plants of great capacity operating by steam power are also in use for irrigation. Large vegetable-growing enterprises render considerable investment in these lines profitable. Their construction and operation are, however, rather beyond the scope of this work. The advice of a mechanical engineer should be secured in all large undertakings.

The Chinese Pump.—A water-lifting device which is very effective for a short lift, as from a ditch or stream to adjoining lands, is the Chinese pump, which has long been in use in California. It is a modified "Persian wheel," and is so simple that it can be home-made with old threshing machine gearing or other mechanical junk. It consists of an endless belt working like the "elevator" or "straw carrier" of a threshing machine. For instance, take an old machine belt eight inches wide and twenty feet long or sew together strong canvas to make one. Make a box or trough about nine feet long, eight inches wide and six inches deep inside measurement, with no ends nor cover. Rig at each end of this box a wheel or pulley over which the endless belt can run. Fasten to the belt, a few inches apart, blocks scant eight inches long and four inches wide, so that the belt will have a flat surface on one side and the other crossed with the blocks. When this is placed in the box and over the pulleys at each end fasten the box securely in an inclined position with the lower end in the water, turn the upper pulley by a hand crank or a small belt from a source of power and the blocks will elevate the water and shoot it out from the top of the box in fine style. For a short lift this apparatus discharges quite a large volume of water with comparatively little power.

DEVICES FOR SELF-LIFTING WATER SUPPLY.

Where running water is at hand in ample supply and with adequate velocity, the water can be made to lift itself to a distributing point, if not too high. The most capacious agencies belong to a class of motors called current wheels.

Current Wheels.—A current wheel is an arrangement resembling the paddle wheel of a steamboat, with a central shaft acting as a hub for the spoke-like arms which carry on their ends boxes or buckets. The wheel is hung by the projecting ends of the shaft so that the buckets are just covered under the surface of the water. The current catches them and causes the wheel to revolve; the filled buckets are carried up as empty ones descend into the water. The filled buckets are emptied as the turning of the wheel inverts them, and the water is caught in a box properly placed and is then conducted by a flume to the point of discharge. Current wheels are largely used for short lifts from streams or irrigation ditches in which the water flows with sufficient velocity to revolve them. The wheels are usually home-made and much ingenuity can be employed in constructing them of available materials.

Hydraulic Rams.—The hydraulic ram is wasteful in that it can deliver at a higher level but a fraction of the water furnished it and it requires a definite fall for its action. Where conditions are favorable it does become an effective agency because it acts incessantly and, with suitable storage, considerable amounts of water become available for irrigation. Manufacturers of hydraulic rams furnish full accounts of their requirements and achievements.

A suggestive combination of current wheel and hydraulic ram, in operation in this state, is described as follows:

> A. P. Osborn's residence and the best part of his land are located on high grounds on the bank of Tule river. To get water on this land without going several miles up the river and bringing out a ditch, Mr. Osborn placed in the river a wheel twenty-five feet in diameter and five feet wide. Surrounding this wheel on either side are forty boxes, each holding four gallons of water, making in all eighty boxes, with an entire lifting capacity of three hundred and twenty gallons at each revolution of the wheel, which is turned by the current of the river. As the boxes reach an elevation of twenty-two feet, the water in them is emptied into flume, which conducts it onward into an irrigation ditch. This elevating the water twenty-two feet is only sufficient to place it on the flat whereon is done the farming, and will not take it to the knoll on which stands the residence. This is accomplished by a hydraulic ram. A part of the water reaching the top of the river bank is allowed to run back down the steep bank through a pipe, thus furnishing motive power to run the ram, which sends water up to the house. The wheel and flume cost, when completed, $150, and, considering the small liability of its becoming damaged, it is certainly preferable to keeping in repair several miles of ditch.

Conveying Water by Siphon.—Conveying water over higher ground to a point of delivery on the other side lower than the supply point is a simple operation, and one which might be more generally employed than it is. A simple instance is this: selecting a low, moist spot over the hill, a pit was dug, twelve by twenty-four feet to a depth of twelve feet. When completed, five and a half feet of water gathered in the pond. An inch pipe was laid along the level about four hundred feet and over a gently sloping ridge twelve and one-half feet above the plain and then down the slope westward about eight hundred feet. At the summit a pump was used temporarily to draw the water upward in the pipe and soon a flow began from the outlet. The pump was removed and the siphon worked to perfection.

Siphons are very satisfactory where applicable and are sometimes made of pipes of considerable diameter where the supply is large. Such devices are vastly cheaper than tunneling. It is even on record that a fruit grower put in quite an expensive pumping plant to force water over a hill to his orchard on the other side and was surprised to find that the water ran when the pump was not in motion. He had not figured that the delivery point was lower than the supply point, but so it was. In the case of conveying water from rivers to leveed lands below the stream, the siphon is cheaper than a flood-gate and safer and has the advantage of being portable.

FARM AND GARDEN RESERVOIRS.

For the construction of a dam to restrain the water of a creek it is always wisest for the man who has had no experience in such work to secure the advice of an expert. Fortunately such men are very abundant in California as dam building has been a profession of Californians ever since early mining days. The making of water-tight dams on a small scale is not necessarily a very expensive operation, but it is liable to become so if not done properly. An experienced man can give suggestions as to the location of the work in view of the natural conditions and the use to be made of the water, the character of natural banks or bottom which it is designed to use and the best materials at hand for building, as well as the proper form of the construction for safety and efficiency in connection with economical completion of the job. Expert advice is especially necessary where dams are to be built for closing natural waterways, for such efforts involve the handling of volumes of storm water which a farmer may have little conception of, though he may have grown up on the site.

The excavation of a small reservoir to collect water from sources wholly apart from a natural water course is a simpler proposition and can be easily done with farm experience and appliances, and on this work some suggestions may be offered.

First: Location is governed by local factors, but it should be at sufficient elevation to deliver the water freely at whatever point its use is desired.

Second: Its area will depend upon the prospective water supply. If this is ample, do not make the pond too small. A circular reservoir with an average depth of four feet through a circular space forty feet in diameter, will hold water enough to cover two-thirds of an acre two inches deep. This will amount to a good soaking of a good-sized farm garden, and is probably as small a dirt reservoir as it will be worth while to make. For smaller storage wooden or galvanized iron tanks can well be used.

Third: In shape the circle is easiest to mark out and construct symmetrically and encloses the greatest possible area with the least length of bank, but on a small figure it may be a little easier to handle teams and scrapers on an oval.

Fourth: A fairly retentive loam free from rock or rubbish, upon a clay subsoil, favors the easiest and cheapest construction of a dirt resorvoir because with careful construction it can be made water tight without using other materials. Clay is disposed to leak through cracking and sand will neither hold shape nor water. Clay and clean sand, mixed, forms an ideal material.

Fifth: The earth surface under both the pond and the banks must be thoroughly cleaned of all sods and trash and the whole area plowed and harrowed well to make it as fine as possible. The dirt should not be dumped on the old surface to start the bank. When the whole is plowed and harrowed the scraper can be started, moving the dirt from the center to the banks, and each scraper load should be spread and lumps broken with a shovel at once, leveling and filling hoof prints so that all tramping or pressure of the scraper in passing may tend toward even packing of the soil. All spots not reached by the team or tools should be tramped by the shoveler so that no loose dirt may be covered. This work should be continued all through the building. The harrow should follow the plow in the bottom before the scraper moves the dirt to the bank.

Sixth: The outflow pipe should be put in early. A wooden box is often used having an interior space of six by six inches, but a four or six inch lap-welded steel or cast iron pipe is vastly better. It should have an elbow turned up on the inside so that a plug with a long handle can be used to open or close the exit. A valve is better than a plug, but it costs more. The pipe should be bedded in a mass of concrete so that it will not be loosened by working the outlet plug or valve.

Seventh: The width of the embankment is governed by its height. The slopes with the best of earth should not be less than two feet horizontal to one foot vertical on the inside; and if the material is light, three to one on the outside will be none too much.

Eighth: The bottom and inside of the reservoir banks should be well puddled. This is done by thorough plowing and harrowing or cultivating to a depth of eight inches and then admitting water slowly and keeping the teams going with the harrow. Begin at the center and work round and round until the mud becomes as smooth as pancake batter, working and reworking away from the center until the puddle is carried well up the sloping bank. This puddle layer, if the soil is fitted for it, will make the pond hold water.

A Small Reservoir in Sandy Soil.—The foregoing construction will not hold water if the materials are too coarse in character. Where percolation is free a water-tight covering for the bottom and banks must be provided. This can be done by hauling in clay for a puddle or the reservoir after shaping may be cemented. In parts of the state where asphaltum is abundant this material is very satisfactorily used, the asphaltum being melted, mixed with the sand and spread on hot and smooth down well with hot shovels and hoes.

Cement can be used in the form of a mortar made of six parts sharp clean sand to one part Portland cement. Apply two coats, and then brush over with a whitewash of clear cement and water. It is not necessary to make walls of brick or stone on which to cement. Cement directly on the earth, even if it be sand or gravel, answers perfectly. As we have no earth-freezing such work is safe. If there should be cracks, give a coat of clear cement and water and it will close them up. But cracking should be prevented as far as possible by being sure that the earth is well settled before cementing.

The use of clay puddle is also very satisfactory. The following is the plan of construction followed by Mr. Edward Berwick, of Carmel valley, Monterey county, in building a reservoir which stood thirty years of constant use:

> My reservoir is eighty feet in diameter and made on land with a slope of say one in forty. I drove a peg in for a center, took a forty-foot line and marked a circle. I dug a trench eighteen inches in width, say three feet deep where the land level was lowest and five feet where it was highest, so that the ditch bottom was level. I filled the ditch with puddled clay, well tamped, then excavated a width of perhaps ten feet, just inside the clay ring, to the level required for the reservoir bottom. I lined this ten feet of floor with clay, being careful to unite the clay of the ditch ring with this floor. Then began clearing out the middle of the reservoir and banking up on this ten-foot floor, and also on outside, at the same time adding clay to the ditch ring as the embankment grew.
>
> When the required excavation was made, cleared up well to the edge of the ten-foot wide floor, I put in the clay for the rest of the bottom, uniting it, of course, with the ten feet already laid, but now covered with the inner embankment. A three-inch discharge pipe was laid at the bottom, with necessary fittings.
>
> The reservoir is nearly seven feet deep when filled, and form's an excellent bathing tank for the family in addition to its irrigation service.

This is a very thorough style of construction. It would be cheaper to excavate as described in the previous list of suggestions and then trust to a clay layer evenly spread over the bottom and sloping sides, but the use of the puddle trench and flat floor is surer to hold water. The puddle trench is carried to the top of the bank;

clay layering on the sloping bank will crack as the water is drawn down and is apt to be leaky. Mr. Berwick has scraped out a very rich deposit of mud and decayed leaves and water weed once since he built the reservoir, thus obtaining a considerable amount of fertilizer, and after scraping, the bottom was given a new floor of clay. He has also raised the sides of the reservoir one foot and put in exit pipes of four and six inches to release water in different directions.

Stone or Brick Walls for Reservoirs.—Very shapely but rather more expensive walls can, of course, be made of stone or brick laid in cement or of reinforced concrete, and in this way the water contents of the same diameter can be increased. The bottom can be puddled or clayed or cemented, according to the character of the ground or the taste of the builder.

Subterranean Reservoirs.—Large shallow wells are often the cheapest reservoirs, and with pumps of large outflow sufficient head is secured for direct application to the distributing ditches. Tunnels are also subterranean reservoirs and are frequently used as such. Both these wells and tunnels are economical of water, as evaporation is very slight. The following is an instance.

Mr. C. L. Durban says that the cheapest reservoir that a man can build on his land for retaining water for irrigation purposes is a tunnel run into a hill. An open reservoir in a cañon or other suitable place, will lose one-third of its water during the summer from evaporation, while in a tunnel there is no loss. A small spring will supply a tunnel with sufficient water for many purposes. He has illustrated this in a practical manner. On his own land at Mesilla valley, he run a tunnel thirty-five feet long into a hill, in so doing tapping a spring; this tunnel he dammed up, leaving a space thirty-five feet long and the size of the tunnel, which is about five feet by six feet, to be filled with water. He says that the tunnel is the cheapest and best form, and that for each dollar expended one can obtain a space equal to twenty-five cubic feet.

Sub-irrigation by Trenches.—Another form of subterranean reservoir consists of trenches filled up to the plow-depth with broken rock. It is prodigiously expensive and seems only worthy of consideration in the improvement of a hillside home place, where satisfaction is not conditioned upon cost. A California instance of the system is the following, found in Lassen county in the improvement of a homegarden:

The grounds have too great a slope for spraying and instead of supplying surface ditches, the owner constructed permanent trenches, which have no outlet except by seepage. These trenches extend one hundred feet in length along the face of the slope, each being eighteen inches deep and thirty inches wide. The earth was scattered on the upper side of each cut, and by a little care in plowing the garden was terraced into slopes of less grade, each one hundred feet long, and twenty-eight feet wide. As a driveway passes along each end of the terrace, nearly all the cultivation is done by a horse turning on the driveways.

The trenches are designed as miniature reservoirs, and are kept nearly full, when irrigation is required, by a small stream flowing from one-half-inch standpipes at one end of each trench. The ground is free from stone, friable and easily irrigated. These trenches proved quite sufficient to irrigate the garden in the long, dry summers of this region, and ground which would not mature white beans, rye, or buckwheat, produced heavy crops of sweet corn, tomatoes, peas, strawberries and all small fruits, asparagus, celery, potatoes, onions, melons, and, in short, the usual variety of first-class gardens. In the middle of the lower terraces, and occasionally about the grounds, are planted a few family fruit trees.

The size of the stream filling each trench is incredibly small. By actual measurement, each trench is supplied by the flow of three quarts per minute; each one of these streams thus irrigating a strip of land twenty-eight feet wide and one hundred feet long.

THE APPLICATION OF WATER.

Many methods are followed in the distribution of water in the garden. Which is the best method must be determined largely by the character of the soil, and to meet this requirement one must sometimes sacrifice some of the incidental advantages of other methods.

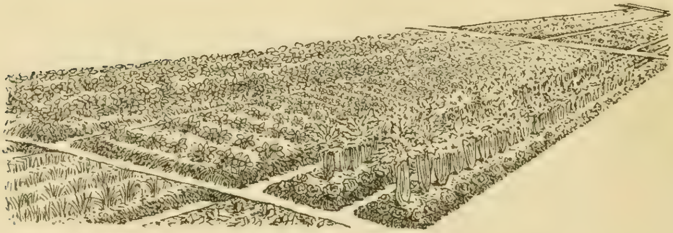
A general statement of the simpler forms of garden irrigation as practiced in California by Prof. S. S. Rogers of the University Farm is as follows:

> "The smaller vegetables such as radishes, onions, lettuce, etc., are usually planted in beds about 10 by 20 feet, throwing a levee a few inches in height around it. These are flooded as often as necessary. As these tender vegetables are very liable to sunburn during the hot summer months the irrigation is usually done in the evening or early morning, for if the water was applied during the midday there would be considerable danger from burning the young plants. After the irrigation the soil should be watched very closely and as soon as it is sufficiently dry a thorough cultivation should be given. If this is deferred too long the ground will become so hard that it will be impossible to get a good mulch. When growing the larger vegetables such as cabbage, peas, beans, potatoes, etc., the water should be applied in furrows between the rows of plants. The earth should be cultivated when it is in the best possible condition, which can only be told by carefully watching each field."

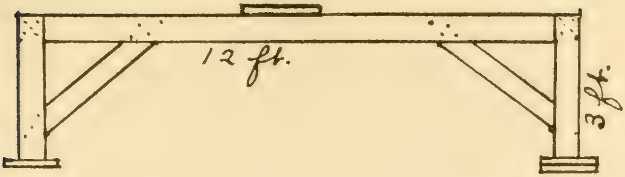
Checks.—Where the garden soil is very light, open and leachy, the vegetables are often grown in checks or divisions larger or smaller, according to the slope of the land; the checks being inclosed by little banks or levees which hold the water from escape except as it sinks vertically into the soil. This is the only way by which a leachy soil can be uniformly moistened, except by sprinkling, which is seldom economical and is seldom followed in California except in village garden practice. The banks of the checks serves as walks upon which one can go dry-shod from place to place and regulate the distribution of water. The garden, then, during irrigation, shows the plants growing in shallow vats of water of irregular shape and size and when the water sinks away they are seen to be in sunken beds. This system sadly interferes with the use of the horse in cultivation unless the ground is practically level and the checks can be made very large. In small checks the cultivation must be done by hand. Market gardeners do this faithfully but the amateur is apt to be careless about it and to trust to frequently filling the checks instead of regularly stirring the soil. This tends to cement the surface, exclude the air and make the soil sodden. The plants lose their free, healthy growth and show their distress.

Raised Beds.—These are just the reverse of the check system for the ground surface is raised a little by the dirt thrown out in excavating narrow ditches about four or five feet apart through which the water is allowed to flow slowly if the ground is nearly level; if slightly sloping, small dams are made at such distances apart as are necessary to hold the water at about uniform depth below the surfaces of the beds. In this system the distribution of the water is very largely accomplished by the capillarity of the soil, though the market gardeners who affect this method also shower the plants from time to time by throwing the water up from the ditch with a scoop shovel or a shallow pan. The narrow ditches serve as walks in working around the beds and rubber boots are in request. By this system ample water supplies are constantly had within reach of the roots and as the surface is never puddled it is easy to keep it loose and open to the air. When the crop is gathered the whole field is deeply broken up with the plow and harrow and the whole system laid out anew, as soon as, in the course of rotation, a crop requiring such hydropathic treatment comes again to the ground.

Depressed Beds and Irrigation System.



Raised Beds or Ridges Irrigated by Capillarity.



Spirit level on frame, to make easy the laying out of contour irrigation.

Permanent Ditches.—The use of permanent ditches was formerly very common in the irrigation of sloping garden ground and is still somewhat observed. These ditches are drawn very nearly on contour lines, only just enough fall being given to move the water slowly. When the slope is nearly uniform the ditches are almost parallel and they are distanced according to what is known of the movement of water by seepage down the slope in each particular soil. The plantings are made on the plan of each strip securing its moisture from the ditch above and water is admitted occasionally or kept running almost continuously according to the needs of the particular crop or the leakiness of the ditch. The outflow from the ditch, after traversing backward and forward its full length, is carried to an alfalfa patch below and thus utilized. These permanent ditches serve a good purpose in saving hillsides from washing as they catch the surface storm water before it has a chance to acquire much headway and carry it down gently. Where the soil favors such distribution very good results are attained with these ditches, but the tendency is to use the ditches too long and allow them to become cemented by action of water and deposit of slime. Besides they grow weeds and distribute seeds if their banks are neglected.

Small Zigzag Method on a Slope.—Contour ditches for single rows of vegetables have satisfied H. L. Wolfsen of Colfax, Placer county, who gives this advice:

> After the soil is prepared, stakes should be placed where the contour ditch will be made. To do this, a carpenter's level is fastened to a board which has two legs of equal length. A half-inch is then added to the foot of one leg which will insure the right amount of fall to the ditch.
>
> Contour so as to wind back and forth down the slope. It will depend upon the kind of vegetables grown how far the ditches should be apart. At the turns, which will be quite steep, stones may be placed to prevent washing. The ditches should not be more than twenty or thirty feet long before they turn, or else the rows will be too far apart. The amount of water to irrigate with will determine how far the patch should extend.
>
> When the ditch is being made, scrape the upper edge smooth, placing all of the soil which is taken out on the lower side and smoothing it, ready for the seeds, or young plants from the hot-beds. Water should be run in the ditch in a moderately large stream at first until it reaches the end of the ditch, and then in a small stream until the moisture shows past the seed row or small plants. Then the water can be stopped and at the proper time cultivate the lower side of the ditch with a rake. The top of the rows will

not need to be cultivated unless the water has been on too long and made the soil soggy. Once the garden is made it is very little work to keep in a tip-top condition.

Lowland Irrigation by Seepage.—Another form of irrigation by means of permanent ditches is that practiced on reclaimed lands along the interior rivers. When the rivers are swollen from summer melting of snow in the high Sierra, the water is brought to the land by flood-gates in the levees. When the rivers are low very capacious pumping plants are used—the same serving at other times to drain the lands when they are too wet from the rainfall or seepage. The soils of these reclaimed lands is loose and prone to dry out because of their lack of capillarity, so that at times irrigation is as necessary as on uplands. The water is distributed by means of small, rather deep, ditches from which moisture readily extends as the water moves out over the clay bottom which underlies most of these lands and makes it possible to hold the water up within reach of the roots of the plants. With rich land, high heat and ample moisture just below the surface the growth is almost marvelous. On these lowlands flooding the surface frequently seriously injures the plants by sun scald.

Ridge System of Irrigating and Planting.—Another plan of using seepage from permanent ditches is the ridge system by which the water is run at a little elevation above the surface, upright plants being placed beside the water on the top of the ridges and running plants on the side of the ridges with the lower ground between the ridges for the extension of their growth. The general significance of the arrangement lies in keeping the water supply constant near the roots, and it is adapted to rather open soils in which lateral percolation is deficient. The elevation of the ditch thus helps to hold moisture near the surface on which the plants are placed without resorting to flooding as in the check system. It is obviously well adapted to a region of very light rainfall and can be laid out in a way to drain the ridges when surplus water has to be disposed of. It involves a large amount of hand work. In a locality where both summer and winter gardening must be largely dependent upon irrigation it has striking advantages. The following description is from a Kern county vegetable grower,[9] who speaks from five years' satisfactory experience with the method:

> In preparing the ground make it as near level as possible, and cover the soil with about two inches of manure (avoid coarse straw or stalks), and plow this under six to eight inches deep. Then harrow and cultivate until the soil is smooth and fine. Use a wire or line to lay out the ground; spread fine manure (well rotted is preferable) two feet wide and one inch thick, on a line directly from your windmill or tank across the plat of ground. Take a plow and turn two furrows together directly over the manure, making a high ridge. Smooth and firm the soil with a rake or hoe, and directly on top and lengthwise of the ridge form a ditch or trough about five inches wide and three inches deep, on a grade so the water will run from one end

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[9] F. M. Reynolds, Delano.

> of the ridge to the other, connecting the ends so that the water will run the entire length of all the ridges without any attention; or you can make the ridges around the plat, which will enable you to distribute the water from the ridge to any point desired by means of a small piece of pipe inserted in the edge of the trough, always maintaining a uniformity of moisture, which is absolutely necessary for the growth of certain vegetables. Run the water through the ditch until it is settled and well moistened, then plant the seed at the base and on either side of the ridge.
>
> Do not allow the water to rise up over the beds under any circumstances. If the work is properly done the water will run through the ditches in the high ridges and from their termination will continue from one trench to another, till each bed in the plat is nicely moistened, and after once thoroughly wet and settled it will not require more than one-half of the water it does at first, unless the soil is very sandy and loose. Remember it is the small stream long drawn out that counts and gives the best results.

Practice with This System.—Concerning practice with the different vegetables and the preparation of ridges and beds for them, Mr. Reynolds gives the following suggestions:

> Plant melons and winter squash seven feet apart on the sides of the ridges, which should be eight feet apart for these varieties, and about five feet apart for corn, beans, summer crook-neck squash, cucumbers, and tomatoes. After preparing the ground and planting the seed neither the ditch nor plants will require much attention more than to keep the weeds out. For the growth of other vegetables, such as peas, cauliflower, cabbage, carrots, parsnips, radish, beets, lettuce, asparagus, egg plant, spinach, peppers, onions, garlic, rhubarb, and tomato plants, prepare the ground by forming it into beds fourteen inches wide and two inches higher in the center than on either ridge, with a small trench between them six inches wide and three inches deep. They can be made wider and deeper if a large amount of water is available. After the beds are prepared run the water through them and recrossing the beds that are defective, so the water will rise to a uniform height on each, within about one inch of the top. Make a depression on each side of the bed two and one-half inches from the edge with a hoe and one and one-half inches deep. Sow the seed not less than one-half inch apart and be *very careful* not to cover the seed more than one-half inch deep. Every good seed will grow, and those which are to remain in the rows must be properly thinned out. When tomato plants are from three to five inches tall, transplant them on either side of the high ridges, five feet apart in the row. Transplant cabbage and egg plants when they are from two to three inches tall, in vacant beds, the former eighteen inches apart in the row for early and close heading varieties, and twenty-eight inches apart for late and spreading varieties, and egg plants twenty-four inches apart in the row. A pint of fine manure from the cow-yard placed six inches below the surface under each plant will insure a cabbage from nearly every plant. Pepper plants should be transplanted eighteen inches apart in the row.

Picturesque Irrigation.—A modification of the permanent ditch plan is quite widely practiced on the sand hills south of San Francisco. The water is lifted from wells by windmills, the discharge from the pump being taken at such elevation that it will flow in a small flume supported by a trestle to the highest point of the land to be irrigated. Hence the water is carried in small contour ditches hither and thither until every corner of the very irregular slopes is reached. Short lines of vegetables are planted about at right angles to these small permanent ditches and short spurs made with the hoe so that the water is brought beside each individual plant. As the slope is so broken and the soil so open, anything like uniform seepage is out of the question. The appearance of these gardens is exceedingly picturesque with the little beds tucked in here and there, showing varying shades of green on miniature terraces and slopes and flats irregularly intermingled often within the area of an acre or two—the lines of the mill frame and flume trestle so thin and long and intercrossed as to suggest that a colossal spider had spun her web upon the verdure. All this is hand work and back work in cultivation and irrigation, in carrying manure up and produce down, and represents a fragment of the south of Europe cast upon the map of California.

Small Furrow Distribution.—All the foregoing methods of distribution may suggest something for the American farm garden in California providing the soil and situation are best served in such ways, but for the most part the farm garden will be upon land of moderate slope with loams which take water well and are fairly retentive of it. Under such circumstances the distribution of water in many small streams along furrows drawn by a small plow, accomplishing complete moistening without flooding of the surface, is the system to be adopted and conscientiously practiced. It is most economical of water not only in the first application but by conservation of its moisture by the thorough surface cultivation which must follow each irrigation. Water is carried along the ridge or ridges of the tract in a plank flume, of dimensions proportional to the size of the area to be irrigated, and with many openings, to be closed or opened at pleasure, so that small streams of water can be brought out into many small furrows and allowed to proceed slowly until they reach the bottom where the surplus may be caught in a cross-furrow and carried to other uses. By this method the water can be evenly distributed with hardly a stroke of hand work and the soil, with its surface always open to access of air, and never allowed to compact itself around the plants, affords conditions perfectly adapted to thrifty, quick growth of the plants. This method conforms best with the most economical laying off of the farm garden, which will be urged later from other points of view, viz.: the planting in long rows with uniform interspaces so that horse-power and the best implements can be employed to their fullest extent in every operation from the seed planting to the gathering of the crop.

Furrow Irrigation on Hillsides.—It is often desirable to make the farm garden on a hillside and this can be managed by horse work without terracing more easily than one might think at first. The plan must be to work nearly on contour lines in laying out the rows of vegetables and in the subsequent cultivation and irrigation. The following will be found suggestive in regard to the distribution of water:

> The water is delivered from a flume laid down the hillside, and fitted with cleats at each hole so as to throw off enough water at the sides, or

sometimes the flume is laid in steps connected with a bit of covered flume from step to step. The latter is best for very steep hills, though, with care, the other may be used on a greater slope than one would imagine. Another flume should be laid at the end of the furrows to carry off the waste water.

The contours may be laid out by anyone with a carpenter's common level. Fifty-five feet to the mile is nearly right for a very fine stream on most soils. And this is about one foot in ninety-six, or two inches in sixteen feet. Therefore take a sixteen-foot plank and level it to a slope of two inches in its whole length. Then when the upper edge of this is level the lower edge will represent the required grade for your ditch. In this way the work can be done very rapidly.

The same thing is equally good for laying common little flumes, cement ditches, etc. But in earth, one should determine by trial the amount of slope the soil will stand without cutting or filling up with sediment or refusing to run fast enough in case the soil is very porous. A mistake of a few inches in a hundred feet will generally not be serious, but the more nearly exact you can get it the better. Every approach to perfection in your first arrangements diminishes your future work and annoyance.

All manner of stuff is now raised in this way in California on hillsides that a few years ago, when covered with brush, seemed too steep and rough even to plow. When once made the furrows, of course, are left in place but the water finds its way to the center between them quite as well as on more level ground.

Irrigation by Sprinkling.—Systems of iron pipe laid below reach of plow and spade and furnished with stand pipes and revolving sprinklers, or other showering devices, have been successfully used to a limited extent, and some have strongly favored them in spite of the considerable cost of the outfit. They are worthy of consideration where water under adequate pressure is avialable. They are labor-saving, but they encourage neglect of cultivation, and to that extent are undesirable, especially on soils which harden on drying. But surface crusting is obviated by using a very fine spray and on some soils is not likely to occur even with coarse sprinkling.

Sub-irrigation by Tile or Pipes.—Californians have been experimenting with subterranean distribution with tile or specially constructed pipes and outlets for probably more than forty years and yet none of the proposed systems have ever come into use except under the eye of the inventor. In early days iron troughs inverted on redwood boards; small flumes or boxes of redwood boards; brick set on edge and covered with boards; drain tile with and without perforations—all these were suggested, given trial and abandoned. All experiments proceeded upon the plan of thus making permanent water conduits below the point reached in spading or plowing, and they all became inoperative. The failure was usually charged to the filling of the pipes with plant roots and in some cases this was seen to be the reason. In other cases the failure of the system was due to the fact that in light soils lacking capillarity, the water rapidly sank away from the pipes out of the reach of the roots and shallow rooting plants failed though there was moisture flowing to waste through a pervious subsoil. Mr. E. M. Hamilton of East Los Angeles invented a system of continuous cement pipes laid by a machine operating in the trench which prevented access of roots because it had openings only at intervals where the water was discharged into air spaces each of which could be seen through a vertical pipe rising to the surface and furnished with a cover. This has worked well for many years on Mr. Hamilton's place for the irrigation of trees or other deep rooting plants at considerable distances apart, for which use it seems best suited. To fill the earth with such pipes with openings near enough together to serve for shallow rooting vegetables, is appallingly expensive, and the stand pipes cumber the surface so that nothing but hand spading or cultivating could be done without destruction of them. It would be cheaper and better to pipe the ground with iron pipes and brass faucets even though the theoretical advantage of subterranean application had to be abandoned.

At the East within a few years the use of the drain tile laid along the rows of vegetables near the surface has given the best results in an experimental way. By this plan the tile are to be taken up and relaid for each crop, which can be quickly done. Water thus administered may serve well in soil not disposed to puddle down or possibly may be more successful where the summer air is less dry and soil baking less active than in California, but in many of our garden soils the soil would solidify, and even if moisture were adequate to prevent baking, the proper entrance of air would be largely prevented. On the other hand, in coarse soils water applied underground would quickly pass out of reach of shallow rooting plants.

The experience of Californians is against any such arrangement of soil and water. Except in such soils as have already been described as working well by seepage systems, surface application of water followed by thorough surface cultivation, produces as a rule the best combination of moisture, heat, aeration and rapid root-extension, which pushes the plant to its utmost in rapid and satisfactory growth.

WINTER IRRIGATION.

Winter irrigation is increasing in California as a surety that the year's water supply will be above a certain minimum. Deciduous trees and vines, on soil that is fairly retentive, can be carried through a satisfactory year's growth and fruiting with good cultivation, by artificially soaking the soil in winter. In this way injury to the trees or vines by a year of scant rainfall is avoided. The practice has not the same value in garden practice because there still will remain the demand for summer irrigation if succession of fresh vegetables is to be secured. But for ample crops of staple field vegetables which are usually grown without summer irrigation, the winter soaking method is of the same importance that it is with fruit trees—it insures ample moisture every year.

Globe artichokes in the foreground of a farm garden near Stockton.—Page 120.

Bean field in the Imperial Valley furrowed out for irrigation.—Page 138.

Fall and winter irrigation are very important in gardening in regions of uncertain rainfall because they bring the soil into condition for the early planting which is often the secret of satisfaction and success. In southern California and the interior of the central regions of the state as well, he who waits for rainfall to start his gardening often loses half the season's producing capacity. In parts of the state the rain at its maximum is seldom excessive, consequently one incurs no danger, but invites every benefit by wetting the soil well and going to work at least with the hardier vegetables while the autumn sunshine still imparts warmth to the soil.

The use of winter storm water often results in a considerable contribution to the fertility of the soil in the form of silt and other materials rich in plant food.

TEMPERATURE OF IRRIGATION WATER.

It is a fact of common observation that a considerable amount of water either from cold rains or from cold irrigation water may cause a "shock" to a growing plant and interfere with its normal development. This fact is accounted for by Professor Hilgard in this way:

> Since the capacity of water for heat is approximately five times greater than that of the average soil, equal weights being considered, it follows that the temperature of the soil water must exert a controlling influence over that of the soil. It is not surprising, then, that the occurrence of cold or warm rains or the use of cold or warm irrigation water, at a critical period, may largely determine the success or failure of a crop.

It is therefore often essential that cold water from a well or stream often needs exposure to the sun in a reservoir, or by running a distance in a shallow ditch or furrow, before reaching the roots of the plant. No temperature gained by such exposure need be considered too high.

This fact, however, has sometimes induced too great expectations from the use of hot water from springs or wells for forcing early vegetables. Warm air is essential to free aerial growth of the plant.

HOW MUCH IRRIGATION IS NEEDED.

It is impossible to answer this question exactly for any crop, but it can be approximated more nearly for an orchard or vineyard or a field crop than for a garden which should be held up to its maximum of free water nearly all the time. Evidently the requirement for gardening is greater than for any other cropping. How much water will be required to hold any piece of land up to its best estate of moisture, depends upon the plant grown, the soil and subsoil, the slope and exposure, the local heat and dryness of the air, the rainfall, etc. The quantity can, then, only be determined for each piece of ground with the data of its conditions and environment, and the observing man will allow the plants to tell him by their vigor and speed of growth how the supply suits them.

It is possible to tell how much water will bring a certain depth of soil into the best condition for growth and working. With this knowledge the gardener can more rationally follow the results of his observation of the plants themselves. The following are the conclusions of the late Professor F. H. King from very careful investigation and experiment:

> The maximum capacity of upland field soils for water ranges from about eighteen per cent of their dry weight for the light sandy types to about thirty per cent for the heavy clayey varieties, while the amounts of water these soils should contain in order that plants may thrive in them best is from twelve to fourteen per cent for the former and from eighteen to twenty per cent for the latter. The growth of plants will be seriously checked in sandy soils when the water content falls below eight per cent, and in heavy, clayey types when it falls below fourteen per cent of the dry weight of the soil.
>
> The dry weight of a light sandy soil and subsoil will average about one hundred and five pounds per cubic foot, and the heavy clayey type about eighty pounds per cubic foot. Hence the maximum amount of water per cubic foot of soil would be about twenty-four pounds for the clay and eighteen and nine-tenths pounds for the sand. This being true, four and six-tenths inches of water on the level would completely saturate the surface foot of heavy clay soil, were it entirely dry to begin with, while three and six-tenths inches would place the sandy soil in a similar condition.
>
> But since water should be applied as soon as the water content of the sandy soil falls to eight per cent and that of the clayey soil to fourteen per cent, it follows that under these conditions ten and five-tenths pounds of water, or two inches, is the maximum amount which would be needed to fill the surface foot of sandy soil and twelve and eight-tenths pounds, or two and forty-six one-hundredths inches, is enough to fill the surface foot of clay soil.
>
> If we consider the second foot of soil to have been dried out to a corresponding extent, and that it is desirable to saturate this with water also, then the amounts just stated would need to be doubled, four inches being demanded for the sandy soil and four and ninety-two one-hundredths inches for the clayey soil. It is quite certain, however, that such an application of water to a field at one time would result in the percolation of a considerable amount of this water below the depth of root action, and hence in a considerable loss of it unless a large crop were growing upon the land at the time. It appears, therefore, that the amounts of water which may be applied to a field at one time will lie between two and five inches in depth over its whole surface.
>
> How often this watering may need to be repeated it is not possible to state in anything like definite terms, but practical experience shows that as a rough average the intervals between watering where maximum yields are sought cannot much exceed seven to fourteen days, the time being shortest when the crop is making its most vigorous growth.

This account is useful as showing how much the soil may be expected to *hold,* consequently the maximum to be considered in application. The times of repetition naturally have to be indefinite because rates of evaporation and leaching are so variable. If the reader should get the idea from these calculations that he ought to have a generous water supply for the best summer growth of vegetables, he will start right at least. He will soon learn how to use the water to the best advantage.

Adequate Use of Water Essential.—Beyond any theoretical computation of the amount of water needed it is one of the plainest teachings of California experience that good, thorough soaking of the ground is the secret of satisfactory results. Surface sprinkling without penetration is a delusion even in lawn growing. It gives the impression of moisture when the roots of the plant may be famishing in dry ground. Pouring on water from a watering pot, though it be once every day, will make a brick to enclose the plant stem and roots if the soil be prone to bake. On larger scale work it has been fully demonstrated that for productiveness a small piece of ground thoroughly soaked with water and then as thoroughly cultivated on the surface to kill weeds and prevent the waste of moisture into the air by evaporation, is preferable to twice the surface only half watered. One very thorough wetting, with good cultivation, will produce better results than several superficial waterings. And in this way the water can be used the most economically by accomplishing the most good with the least labor.

Another very important point is to keep the moisture supply always adequate. One who waits till the plants show distress has lost his chance. One of our experienced growers very pertinently says: "If we allow our ground to get the least bit dry the vegetables are stunted in growth, and then it takes several days to catch up again if it ever does. I hold that a stunted vegetable is as bad as a stunted calf or pig. It is never as good as if it was pushed right along from the beginning."

Besides, it should always be remembered that the edible plants we call "vegetables" must generally be crisp, or tender in tissue, and juicy. Both qualities are promoted by quick growth and quick growth depends upon ample soil moisture. And yet excessive use of water must be guarded against. Professor S. S. Rogers truly says:

> Where water is easy to obtain the tendency of many growers is to overirrigate, not relying upon good thorough cultivation for retaining the moisture. Overirrigation tends to produce vegetables of more or less inferior quality, and one of the greatest dangers lies in the packing of the soil immediately about the plants, especially where the soil is of a heavy nature. It is better to irrigate seldom and cultivate often and thoroughly than to irrigate frequently and cultivate seldom.

RELATION OF IRRIGATION TO SOIL FERTILITY.

And it must also be borne in mind that adequate moisture must always be accompanied by adequate supplies of plant food in the soil. The gardener who keeps his soil rich gets the greatest return from the water he uses, and attention must be paid to the suggestions in the chapter on Fertilization. This has always been demonstrated by experience, and an interesting measure of the fact has been deduced from experimentation by Dr. J. A. Widtsoe of the Utah Agricultural College. He shows that a given amount of moisture will produce at least 30 per cent more crop on rich soils than on poor ones, and the crop grown on the rich soil will contain at least 45 per cent more food value than that grown on the poor one. In other words, the moisture that would produce 100 pounds of crop on a poor soil would produce at least 130 pounds on a rich soil, and the crop raised on the rich soil would contain on an average 45 per cent more protein, which would still further increase the food value of the crop grown on the rich soil to the equivalent of 188 pounds grown on poor soil; almost twice as much food value on the rich soil as on the poor one from the same amount of moisture. Then again the rich soil will hold more moisture, and if there is plenty of moisture the rich soil can grow two or three times as much crop as the poor soil and with a food value that is higher.

CHAPTER VI.

GARDEN DRAINAGE IN CALIFORNIA.

It may be remarked, as a generalization based upon a wide view of our two-season year, that the secret of success in California vegetable growing consists in getting plants "out of the wet" at one time and into it at another. It would, perhaps, be more exact to say that success lies in securing generous but not excessive moisture at all times, and this is essential to the best growth of the plant in any climate. And yet so strikingly antithetical are our moisture-extremes at the heights of the two seasons, and so characteristic, both in times and methods, are the policies and practices by which we modify both to the best advantage, that the world-wide principles to which they conform are out of sight of the casual observer. For it is not only that we have always to guard against extremes of saturation and aridity and keep the plant along the lines of sufficiency—that is the universal proposition. In addition to this California, speaking generally, has to do special work against one extreme at one time and against the other extreme at another time; hence the opening remark.

Regulation of moisture in California either involves more considerations than are usually recognized in humid climates or involves them in higher degree and imputes to them increased significance. Choice of location and soil; time and method of planting and cultivation; the choice of the crop with reference to natural moisture supply and the atmospheric conditions; the employment of irrigation; and the desirability, or otherwise, of artificial drainage facilities—all these are factors which are perhaps more sharply concerned in results here than in humid climates, because our extremes, in all except low temperatures, are more exacting. Correct practice here gives grand results, but ill-timed or illy adapted practice does not give merely less satisfactory results: it may invite failure. Our drainage proposition must always be conditioned upon proper conservation of moisture, and as will be seen as we proceed with the discussion, contemplated artificial drainage may have the power to make or ruin a crop if its action is not intelligently employed, or intelligently rejected, as the case may require.

Benefits of Drainage.—It may be admitted at the outset that in regions of heavy rainfall or in locations subject to much percolation from higher lands, underdrainage may be necessary to satisfactory use of the land in winter gardening unless the soil is deep and free enough to readily dispose of the surplus water. As a matter of fact, it is necessary in some cases, and gratifying results follow in lowering the ground water, admitting air, warming the soil, making it hospitable to the plant, rendering fertility available and lengthening the growing season of the plant both by these services and by making the soil sooner amenable to tillage and susceptible of better tilth. All these are general drainage principles applicable here as elsewhere and in some soils and situations the same method of application is best, viz.: thorough under-drainage preferably with tile, but also attainable with trenches partly filled with rock, or with regular runways with placed stones or poles or boards or whatever may be most available to the person at the time. In drainage for garden purposes, however, it is not necessary that the water table should be lowered as far as is essential to the satisfactory growth of trees, nor is it desirable generally that it should be. Tile laid two feet from the surface will answer in many cases if the land lies well for the outflow of the drainage.

Conserving Moisture.—The general purpose in California gardening must be to save moisture, not to facilitate its escape. It is especially important in an arid country that the lower strata of the soil should be a storage reservoir for the use of the plant in the dry season. This fact underlies the recommendations for cultivation which will be given in a later chapter, but it also has intimate relations with the subject of drainage. Evidently recourse to drainage should not endanger the generously adequate moisture supply which the plant needs, and for this reason the almost universal exhortation in gardening treatises for humid climates: "first of all deeply drain your soil," either subjects the trusting Californian to a useless expense or, worse than that, makes his land less suited to his purpose than it was before the expenditure was made.

For it should be noted: first, that our light deep loams which are chiefly used for garden purposes, can naturally dispose of all the surplus water which the clouds afford them; second, our heavier soils sometimes make a great surface show of saturation when the lower layers have really far less than their holding capacity, because percolation is slow, not only by nature of the soil but by the lack of thorough tillage which would help to hold a large precipitation until the soil cold absorb it; third, our soils dispose of moisture very rapidly during the dry intervals of the rainy season, and this can be increased by winter cultivation which should not aim to fine the surface but to open it to the air; fourth, by their active winter growth, the plants themselves pump from the surface layer volumes of water, the escape of which opens the way for capillarity to relieve lower layers of their surplus, and thus the active roots help to prepare the way for their own further extension.

Really, then, what California soils need for winter garden purposes in natural surface drainage, viz., downward into thirsty lower layers; upward into the air by evaporation from earth-surfaces or plant-surfaces. Where this is not adequate to the relief of surface saturation and consequent preparation for seed sowing, very simple artificial surface drainage is usually effective. This can be mainly accomplished with the plow, first by opening drainage furrows at proper intervals, and this is often all that is needed to dispose of surplus water; second, by ridging with the plow which prepares long seed beds a little above the general surface and at the same time leaves channels for the escape of the water; third, by opening deeper surface-drains to act directly or to receive and speed the departure of the outflow from the open furrows. All of these forms of treatment, selected according to the degree of the need of drainage, have proved widely satisfactory and have facilitated magnificent winter growth of vegetables upon heavy adobe soils in some of our regions of heaviest winter rains. The action is quicker than underdraining because percolation is notably slow in such soil. It removes the surplus from the surface just at the time its absence is most desirable and it leaves the moisture stored below to rise as the demand for it advances. On the other hand underdrainage, where it is not imperatively demanded by exceptional conditions, has clearly acted too slowly to bring the surface speedily into satisfactory condition and has acted too long in drawing away more water than desirable from below and has then continued as a very effective hot-air system for further drying of soil-substance which should have retained more moisture to supply the plant and foster capillary action from still lower layers. In the writer's own experience shallow-rooting plants have dwindled over tile lines while those midway between the lines were growing rapidly.

Conditions Determining Recourse to Underdrainage.—It may be well to specify a few of the conditions which should determine whether underdrainage should be provided in land under consideration for vegetable growing. Of course the claim already alluded to, that any piece of soil selected for gardening must be first underdrained, is an exaggeration anywhere in the world probably, because there are areas of naturally well-drained soil everywhere. Enough has been said of California garden soils to show that the most of them are of this character and that no probable amount of rainfall would injure them. The exception has also been sufficiently characterized in the chapter on soils.

To reach assurance for or against underdrainage in particular cases one has to consider the soil, the rainfall, the character of the root growth to be ministered to, the growing season of the crop and the practice of irrigation.

The mere amount of rainfall is so intimately related to soil texture, depth, subsoil, slope and exposure that, considered alone, it affords no guide whatever to the need of artificial drainage. There are many situations receiving an annual rainfall of forty to sixty inches which not only do not need underdrainage but, on the other hand, irrigation must be employed as early as May to supply the requirements of shallow-rooting plants. These are either coarse leachy soils or else shallow loams lying upon sloping and porous bed-rock. Leaving these out of consideration it is doubtful whether any land, even of quite retentive character, receiving a rainfall of not more than twenty-five inches, distributed as California rainfall usually is, needs underdrainage for garden purposes. Of course this claim clearly presupposes that the land in question does not receive any considerable amount of water by overflow or underflow by seepage from higher land. Any such rainfall as noted can probably be controlled by such surface use or surface release as has already been described, or by such early and deep cultivation as the garden should receive, there can be stored in the soil the moderate residuum remaining from the amount of rainfall indicated, and under favorable circumstances a greater rainfall can be thus disposed of.

Deep rooting plants like fruit trees will, of course, be injured by saturation of the subsoil which would not injure garden vegetables, therefore underdrainage of the orchard is a different proposition from that of the garden. It should be stated for the distant reader that the term garden in California is not understood to include fruit trees, except in villages or suburban places.

The growing season of the vegetable crop is also related to the matter of underdrainage. While the winter garden on a retentive soil in a region of quite large rainfall, may be greatly improved by underdrainage, the summer growth of the same plants perhaps, and of field crops of shallow rooting vegetables, may be benefited by such surface treatment during the winter as shall promote the absorption and retention of the whole rainfall in the soil and subsoil. This practice may insure the perfection of a crop without irrigation which could not be grown on a less retentive soil nor on one currently drained of its surplus water.

The practice of irrigation may create a need for underdrainage which may not exist on land used for rainfall-gardening. If the soil is naturally well drained this need will not, however, occur unless the natural escape of surplus water has been destroyed by rise of the bottom water which has, in some large districts in California followed excessive irrigation, and the seepage of water from leaky ditches. Especially unfortunate, too, has it been that this rise of the ground water has brought within reach of capillary action and surface evaporation, alkaline salts which are destructive to vegetation. But here again the growth of vegetables can be successfully pursued on lands with water too near the surface to favor fruit trees, providing the rise of alkali does not occur. For the growth of vegetables, then, it is not generally imperative that the land be underdrained even if irrigation is practiced though there are cases of retentive soils in which this is desirable. In irrigation in a humid climate where a heavy downfall of rain may immediately follow a saturation by irrigation, underdrainage is a safeguard. California with a rainless summer, is freed from this danger.

Too great emphasis, even to indulgence in repetition, can hardly be placed upon the point of view held in this work. We are

Digging sugar beets with a tractor on the Meek Ranch near Antioch.—Page 155.

Section of a cabbage field in the Modesto District, San Joaquin Valley.— Page 159.

dealing for the most part with plants which are used before maturity and in which large free growth of foliage, stem and seed vessel are the points desired and not mature seed. Most of these plants are also shallow-rooted and are concerned in the lower layers of soil not as a place for root-activity, but rather as a reservoir of moisture and a storehouse of plant food which shall come to them dissolved in the upward movement of abundant water. Consequently these plants do not require the degree of soil dryness which best ministers to maturing processes nor do they need such deep penetration of air as is needed to make subsoils hospitable for deep-rooting plants. They are plants, too, which need the maximum percentages of moisture, which their nature demands, to secure the quick growth and succulence which makes them delicious and profitable, as already stated in the preceding chapter. For all these reasons, the view of underdrainage here presented is somewhat at variance with orthodox drainage tenets held in humid climates and is also widely diverse from views which the writer holds with reference to the drainage requirements of fruit trees. But there are, of course, some situations in which water may accumulate to saturation, rendering the soil cold and water-logged. In such cases drainage is indispensable for early planting to get growth well started or complete in the rainy season, but the opposite may be true of the same situation and soil if desired for late planting and growth in the dry season.

CHAPTER VII.

CULTIVATION.

The timely and thorough performance of the several acts which, in accordance with the prevailing local conditions, constitute good tillage, are indispensable to success in California vegetable growing. No matter how favorable the natural conditions or how generous the other provisions made by the grower, to be dilatory or slack in cultivation is to seriously endanger, if not to actually forfeit, the final reward.

The American pioneers were quick to see that the energetic use of the good tools to which they had been trained in their old homes would bring marvelous production from lands previously held at grazing value, and, beginning with this assurance, they proceeded by lessons of observation and experience until they learned proper times and ways of working under the novel natural conditions which surrounded them. They also accomplished modifications in tools for tillage, which, from a local point of view, are notable improvements, and they devised new forms to meet special conditions or purposes. By this empirical method they ministered to their own success and incidentally demonstrated the truth of some advanced theories of tillage which had won but slight recognition from the conservative spirit of the older countries. It is an interesting fact also that prevailing California practice, in some important regards, accords more closely with principles deduced from elaborate experimentation by the most acute and patient students of soil physics, than does the common practice of older countries. It is in some sense a grim satisfaction for Californians to feel that critics who have denounced some California tillage practices as slack and unthrifty, not only do not know our conditions but are not aware that their own practices are in contravention of general principles with which ours closely agree.

With tillage, as with other gardening duties to which reference has been made, there are in California wider extremes to be mastered, and methods are therefore strikingly diverse. Tillage prepares the seed bed, facilitates germination and root-extension, and fosters the benign processes of soil warmth and aeration, here as elsewhere. It also holds the same relation to soil-moisture here as elsewhere, but its services in this particular are more conspicuous because the need is greater, as intimated in previous chapter.

The common California conception of the value of tillage naturally seizes upon this aspect of the case and asserts that the chief offices of soil working are first to get as much moisture as possible into the soil and, second, to keep it there. The efficacy of certain ways and times of tillage to assist in the escape of surplus moisture is, of course, known to those who have this work to do, but the area in which such acts are called for is comparatively small. It is quite important, however, that the vegetable grower should have it in mind and it will be mentioned later.

All soil-stirring should be undertaken, as nearly as possible, when the soil is in best condition to receive it—that is when it crumbles best. A rough determination of this is to lift a spade full to an adjacent surface and strike it with the flat of the spade. If it crumbles well it is in working condition. In the case of raking or cultivating the crumbling of surface clods indicates similar conditions.

TILLAGE TO RECEIVE MOISTURE.

This involves both time and method. The importance of early work in the garden has been incidentally mentioned and will be further urged hereafter. With the rainfall-vegetable grower, early plowing of the land, or early digging of the small garden, is the first of a series of timely acts which are neglected at great peril.

Summer Fallow as Preparation for Vegetable Planting.—The best way to be early with one season is to begin in the previous one, if possible. A bare but frequently-stirred summer fallow is the best preparation for a garden. A piece of stubble or new land deeply plowed and subsoiled and left unharrowed in the fall or early winter, cross-plowed in the spring, and then worked with a cultivator once a month during the dry season, is brought to the opening of the rainfall garden season in good condition from at least three points of view: first, it has been cleaned of many weeds; second, it has been improved in tilth and fertility and, third, it has a storage of moisture from the previous season's rainfall. Such a piece of land can be deeply plowed at the opening of the rainy season, and can be at once planted with vegetables for winter use which are hardy in the locality and will carry them along well with its content of stored moisture, even if there be very little rain during the early fall months. Because of its deeply stirred surface, freedom from hardpan from previous cultivation, and moist subsoil, it is in its best absorptive condition and by subsequent shallow working as each vegetable is disposed of, rotation or succession can proceed on the same ground and with the advancing winter and its added rainfall, planting of less hardy vegetables can be made until the frost-free period arrives and the garden will go out into the spring and summer growth of nearly the whole list of hardy and tender plants with ample moisture to carry them to perfection during the dry season if the local rainfall is adequate.

Early Beginning for Work the Same Season.—But it is not always possible to give the year of rest and cleaning and moisture-saving, desirable as it is. In that case the plowing must be done dry or the land deeply irrigated before plowing, or the plowing deferred until the rains sufficiently moisten the soil for deep plowing. This last method usually limits the practice of autumn gardening and emphasizes the desirability of a water supply for irrigation. Sub-soiling may also be done with advantage if the rainfall of the region is generous; if not, there is too great danger that much of the moisture may go out of reach of the shallow-rooting plant. It is usually not as safe to plant as early on newly plowed land as upon replowed summer fallow, for, unless the fall rains are above the average, the plants may be less thrifty than those planted later when full moisture is assured. This is, of course, a matter for local determination as it is conditioned upon local rainfall. It should also be observed that in plowing for early fall planting the land should be harrowed immediately, for there is more danger of losing moisture by evaporation than of getting too much from the early rains, which are usually light. In early plowing to catch winter rains with the idea of planting after the heaviest rains are over, say in February, the early plowing may be left rough until near planting time.

Even if for any reason it is not thought desirable to plant vegetables in the open air until February, and this is a practice in localities where fall and early winter temperatures are rather low, still the early plowing is necessary to moisture-saving and cross-plowing should follow in preparation for planting.

Land designed for spring planting of tender vegetables should also receive early and thorough fall plowing and a subsequent winter plowing or spring plowing before the weed growth becomes too heavy for turning under or so coarse that plowing under will make a non-retentive soil still more prone to drying out the following summer.

TILLAGE TO CONSERVE MOISTURE.

Tillage to receive moisture is designed to open the soil and to assist percolation to prevent surface run-off and to absorb the rainfall. Tillage to save moisture aims to reduce evaporation to a minimum. In a firm soil moisture rises by capillary attraction and is rapidly removed from the surface by evaporation. A light soil has less capillarity, or ability to draw moisture from below, than a heavy one. A sandy soil has less than a clay, but both lose water by surface evaporation until, in an arid climate, plants will die of thirst unless they be by nature drought resisting. Garden vegetables are not of that character; in fact quite the reverse. Consequently some means must be adopted to prevent the moisture which is rising in the soil from reaching contact with the outer air. This can be done by placing a covering upon the compact portion of the soil so that the air shall not have free access to it. Covering with a sufficient amount of almost any coarse material, such as is commonly known as a mulch, will answer. But the use of coarse manure or rotten straw or sawdust or anything of that sort, is troublesome and expensive and otherwise objectionable, although it has an acknowledged place in garden practice, as will be shown later.

The Earth Mulch.—California practice has made the widest application of the truth that a finely pulverized surface layer of sufficient depth is an effective mulch. Pulverizing the soil widens the distance between its particles and consequently destroys its capillarity until by the action of moisture, either in the form of liquid or vapor, it becomes again compacted to a degree which restores its power to transmit moisture. The cultivator has it, then, within his power to spread a mulch and check evaporation simply by fine and frequent pulverization of the surface layer by cultivation. It is this ability which enables the California horticulturist to transform the lower layers of his soil into a reservoir, and to profit by the natural tendency of the moisture to rise in the compact soil until it reaches the point where the pulverized layer checks its advance. This practice makes possible an achievement which seems almost incredible to workers in humid climates, viz.: the growing of a succulent crop from seeding to harvest without the use of a drop of water either by rain or irrigation, and it is this practice, coupled with the deeper rooting habit of plants which is induced by it, which enables our trees and field crops to grow thriftily and produce heavily during months of drought, while a few weeks of drought may bring distress to plants in humid climates.

But the pulverized surface layer must do more than arrest the capillary rise of moisture before it reaches the surface: it must check it at a point out of reach of the free entrance of air through the loose layer, consequently the degree of pulverization and the depth of the loose layer are factors to be carefully observed. It is not enough to grind an inch or two of the surface to powder. The free movement of air through this shallow layer, at least in our summer air with its exceptional thirst, will proceed with evaporation from the too thinly covered compact portion and the loss of moisture will be only a little less rapid and complete than if the surface had not been disturbed at all. The same thing will happen if the surface layer be only coarsely broken to a still greater depth: the passage of air through the clods will be free enough to draw off the moisture and the soil will dry out to a degree which will bring distress to plants which good cultivation would have maintained in vigorous growth. It is plain, then, that the earth mulch must be fine enough and deep enough to serve its intended purpose and for this no arbitrary rule can be laid down except that the coarser the soil by nature, or the coarser the particles by cultivation, the deeper the mulch must be. The practical test is easy; if the pulverized layer becomes dry and if on brushing it aside with the foot, the earth below is hard and more or less dry also, the mulch is not effective and its character must be improved.

Steps by Which Conservation is Attained.—The foundation for a satisfactory moisture-conserving tilth is laid with the plow during the fall or winter preceding the summer during which it is to be maintained. Though plowing has been considered as a factor in opening the soil to receive and store moisture; it is also considered in its conservation. To do this the plow must be used when the soil is in the best condition not only for turning but for disintegrating by the crushing action of the moldboard so that the soil particles shall lie closely upon the firm portion and not form large air spaces which minister to drying out. Plowing when the soil is unfit results in clods, which are every way hateful in the garden, and in air spaces, which are objectionable, as shown. Even when the soil is in reasonably good condition, late plowing, if left rough and open to dry winds, will form clods in all except the loosest soils, consequently all late plowing should be at once well harrowed.

The next step in the assurance of a good earth mulch is the early use of the cultivator. It will not do to allow the harrowed soil to crust by rains and then trust to some later rain to loosen and rescue the young plants from its embrace. Just as soon as the soil arrives in condition after a rain, stir the surface well and the crust will not be formed, and this must be done just as often as crust-forming conditions recur. In this way the soil surface is constantly kept in good absorbing condition and is also carried on its way to the best conserving condition as well. Weed growth, which is moisture wasting, is also prevented.

Then comes the summer cultivation to retain such an earth-mulch as has been described. If it proceeds upon previous good work in clod and crust preventing, the vegetable grower is fortunate. If not, he must have recourse to whatever implements for clod crushing, cutting, chopping and grinding, work best in his soil, for, as there can be no best plow for all soils, so also there can be no best cultivator. The grower must learn to recognize the condition which he wishes to attain and then experiment with tools until he finds the best for his soil. Summer cultivation means cultivation all summer, or at least as long as growths are still progressing. To reduce to good tilth in the spring and then "lay by" the garden or else to count upon later cultivation only in the case of later rains, is not adequate cultivation for moisture conservation. The earth mulch will have its capillarity restored by its own absorption of moisture from below or from the air, and it will lose its efficiency as a protecting cover even though no rain falls. Therefore frequent stirring to adequate depth but without soil-turning must be maintained at intervals both to restore the mulch and to destroy weeds which may start late and pump moisture away from the plants in almost incredible amount. Remember, though no crust forms and no weeds start, the cultivator must frequently restore the surface layer to its condition as an efficient mulch if the greatest possible amount of moisture is to be conserved.

CULTIVATION IN SMALL GARDENS.

Work with spading-fork, hoe and rake in the hand-made garden is subject to exactly the same requirements as those described for the horse-power garden or vegetable field. Early and deep digging for moisture reception and storage, as well as to welcome root-penetration, must be followed by coarse raking to maintain a surface fit for absorption and not favorable to crusting while the rainy season advances, and after the rains have ceased, there must be frequent deep hoeing and fine raking to maintain the earth-mulch which has already been characterized.

The Man with the Hoe.—The use of the hoe at different seasons in the California garden and the contrast between summer hoeing as practiced in arid and humid climates is so strikingly illustrative of the sort of tillage which gives in California rank summer growth without rain, that a few comments will be indulged in.

The first and most obvious reflection which comes to one who does summer hoeing in an arid land is that the handling of the hoe which he practiced in his boyhood in eastern garden or cornfield is not the hoeing which avails most now and here. The light, shallow stroke, which fell just below the root crown of the weed, stirred the immediate surface a little and left the field clean, used to be the touch for eastern hoeing, and a man could almost do it at walking speed for hours upon hours. Except a little extra deep work, which was called for when the occasional short droughts threatened, this shallow weed-cutting was sufficient to give the crop the upper hand in the struggle with weeds, and the frequent showers kept the surface moist enough to prevent baking.

It is to be inferred from recent reports that there is less shallow hoeing done now than a generation ago at the east, and deeper summer cultivation has been found profitable there. However this may be, it is clear that shallow hoeing is a delusion and a snare in this country. Practice it through the spring and as long as the weeds start, and your garden surface will be dusty. Think then contentedly about what you have heard of a mulch of dust-retaining moisture. Can it be possible, instead of shooting upward, the plant just holds its own and then goes backward, wilting, yellowing its leaves, and all but dying in its distress? Surely there must be a worm at the root. The hoe is seized and brought down upon the soil at an angle and with a force it has not known all summer. How the dust flies from the surface, and how the hoe flies from the hardpan just beneath the dust as though it had been brought down upon a marble slab. Then there come to mind thoughts on hoeing which never came before. Then it becomes plain that the shallow weed-cutting stroke is not the dash of the hoe which saves the plant.

One who goes through this experience once will know better how to hoe next time. He will see that by sharp, deep strokes, often using the corners of the blade, he will maintain a loose layer upon the surface which will be thick enough to prevent direct evaporation from a hard-pan layer and thus to break the connection between capillary action and the atmosphere. Such hoeing is harder than light work with the blade nearly horizontal. It takes muscle to give a strong vertical stroke which penetrates well, and one cannot waltz along the rows whistling a lively tune, as is quite possible while weed-cutting in moist soil in February.

There is little grace, we admit, in the attitude of the Italian market gardener, as he straddles the row, arches his back and grunts as he sends his heavy mattock its full depth into the soil around the plants. The American with his fine, new, full-width, bronze-shanked, green-labeled, steel hoe, marching along the rows, touching the soil with disdain as ill worth exertion on his part, is a much handsomer picture. But the Italian's plants laugh at drought. When irrigated the soil takes water like a sponge and it goes plump down to the roots of the plant. Irrigate the shallow-hoed plat; a pailful will run a rod and the plant root gets but the gurgle of the water as it flows along the surface of the hard-pan just beneath the dust.

Evidently, if one begins early in the season with deep hoeing, the midsummer tussle with hard-pan will be obviated. This is really the lesson to be learned.

A Straw Mulch.—In some cases a mulch of rotten straw, old leaves, etc., may be substituted for the earth mulch produced by tillage. It covers the surface from direct contact with drying sunshine and air and retains moisture within reach of shallow roots. Such material is usually put in place after the plants are up and high enough to have their tops in the light while the litter shades the ground and the lower parts of the stems. This saves hoeing and conserves moisture and many growers strongly favor such a mulch for tall growing plants. In the case of potatoes it is quite possible to place the mulch right after planting, for the shoots readily find their way through several inches of light coarse stuff, while many weeds will be repressed by it. Water may be applied by sprinkling on top of the mulch.

CULTIVATION AND IRRIGATION.

All that has been said about the relations of tillage to reception and conservation of moisture from rainfall is of equal truth as related to moisture derived from irrigation. Soils not readily absorptive must be opened by proper tillage to receive the waterflow. Such is the service rendered by the furrow system in addition to its furnishing channels for the flow. Soils naturally open will take water as well, and sometimes better, by other methods, as has already been explained. But by whatever means water is brought to the soil the conservation of the water depends largely upon the prevention of surface evaporation which not only releases moisture but turns the upper soil into a pavement which is fatal to shallow-rooting plants. Therefore let the plow follow the irrigation, if it is fall or winter irrigation for the preparation of a seed bed, and let the cultivator do its work finely and to sufficient depth if it is summer irrigation for advanced plant growth. Do not let the irrigated land lie until it yields clods to the cultivator. Seize it soon, as good tilth waits on stirring; "and when 'tis done then 'twere well it were done quickly."

But soil stirring after irrigation is also the surety of effective irrigation. "The first thing when flood water leaves silt here in Coachella valley is to flop the silt under as soon as you can get on the land," says Bruce Drummond of the Indio Experiment Station. "If you don't, it seals your soil up and your irrigation water doesn't get through it. I am kept on the go most of the time to answer questions of people who want to know what is wrong with their trees, truck, etc. In many cases I can take a shovel and show them that they are not getting water down to the roots."

RIDGES, HILLS, RAISED BEDS AND LEVEL CULTURE.

Though the considerations suggested by these words are involved in irrigation and drainage, they are commonly regarded as phases of cultivation. It is almost obvious that all methods of lifting the plant bed above the common surface are equivalent to providing it with the fullest facilities for surface drainage. Whenever, then, ridging or hilling or raising whole garden beds is practiced without connection with irrigation upon the elevated surface, it affords exceptional means for the escape of surplus water and relief to the plant from saturated soil. By this act the winter growth of vegetables, hardy enough to withstand the local climate, can be carried on in the most retentive soil under a very heavy rainfall.

Ridging.—It matters not whether this ridging is done very quickly with the plow by back furrowing or whether a raised bed is made in the small garden with a retaining border, the principle is the same and it is a very useful one. It affords a ready answer to the requirement which exists in many parts of California for facilitating winter growth by drainage without at the same time endangering too great loss of water for summer cropping. The back furrow gives the plants a greater depth of stirred soil, which is especially valuable in the rainy season. After the early crop of hardy vegetables is disposed of there will still be time to plow down the ridges and put the soil in receptive shape for the late winter or spring rains, cultivating being done later to retain moisture until the frost-free period arrives, when the same land will take its summer crop of tender vegetables with or without irrigation as the character of the soil, the proposed growth and the local rainfall shall require.

Raised Beds.—A more elaborate application of the same principles consist in the raised beds, which are very useful for winter growth in the small garden and, in combination with irrigation by seepage as already described in the chapter on that subject, afford a means for applying water or escaping from it as the conditions at any time shall dictate.

Another form is the permanent, bordered, raised bed of the kitchen garden, which is very serviceable either in farm or village growth of home supplies by hand work, both in cultivation and sprinkling. This is the method by which the late Ira W. Adams, of Potter valley, one of our most resourceful vegetable growers, applied the principle on a small scale:

> I made my beds four feet wide and any length desired. As my land is little on the adobe order I put on three or four inches of fine creek sand and a very heavy dressing of thoroughly decomposed mixture of cow, horse, pig and hen manure. My beds are twenty feet long and I confine the soil in them by laying a round spruce pole on each side, said pole being about six inches in diameter at one end and five at the other; a little larger or smaller will answer. By driving a small stake at each end of these poles and one in the middle, and fastening them to the pole by a single nail in each stake, a great saving of space is made on the edges of the beds, as without some protection the heavy rains wash the edges of the beds very badly.
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> A few days before sowing the seed, in September, I water the bed very thoroughly until the soil is thoroughly saturated to the depth of eight or ten inches. Leave it until it is in just the right condition to work. Then incorporate the sand and manure into the bed in the best possible manner by vigorous use of a six-tined hoe fork with round steel teeth about one-fourth of an inch in diameter and eight inches long. This thorough work, with the addition of the sand and manure, leaves my beds about eight inches above the general level of the land, and between each bed I leave a walk fourteen inches wide.
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> Some may say it is a great deal of trouble to prepare such beds. Granted; but when the beds are once *carefully* made they are fit for immediate use at all seasons of the year, and for many years to come, not only for onions, but for early lettuce, radishes, turnips, table beets, dwarf peas, etc., that require a light, rich, and well-drained soil. An application of a little liquid hen manure occasionally is very beneficial, and is all the fertilizing the beds will need for many years.

This shows small-scale, intensive work. With such beds it is possible to have vegetables in edible condition, before it would be wise to sow seeds of the same kinds in open ground in the same locality.

Hilling.—Hilling of plants to afford soil-room for growth started from shallow planting is another means of attaining drainage and soil warmth during the winter season. It is the ridge principle applied in spots and with vastly greater labor. If one has a fancy for it he can indulge in it in a hand-made winter garden, but otherwise there is nothing to be said for it.

Flat Culture.—All references to systems which lift the plant-bed above the common surface should be accompanied by the clear declaration, that except as associated with the distribution of irrigation water, they are a delusion and a snare if carried into summer work. The very release of water which fits them for winter use unfits them for the dry summer. Level culture is the broad basis upon which summer conservation of moisture rests. The plant root should neither be lifted into the air nor should the soil be opened so that the air is allowed to freely descend to the plant roots. Soil and air assume proper relations when the culture is flat and fine and sufficiently deep.

Tillage to Release Excessive Moisture.—The occasion for this course, except in stated winter practice already described, rarely occurs in California except on lowlands in regions of ample rainfall, though sometimes a large precipitation in a short time may too long delay planting until the surplus is disposed of. Plowing with rather a long slope of moldboard, which turns furrows without crushing and laps them well, leaves air spaces at the bottom of the furrow-slice and aids greatly in drying the soil. Sub-soiling also allows water to percolate and air to enter freely. These are, however, heroic treatments and if employed late in the rainy season are apt to give the lower layers of the soil opportunity to dry beyond desirable moisture retention. If only a slight surface drying is necessary a narrow-toothed harrow or cutting discs with slight lateral pressure will accomplish it.

CHAPTER VIII.

FERTILIZATION.

In the chapter on soils there has been given a glance at the leading characteristics of California soils, including their endowment of available plant food. This natural fertility is the explanation of the fact that in this state up to this time the question of fertilization has been of minor importance. The securing and husbanding of adequate moisture constitute the key by which native fertility is unlocked and so long as this resource permits the gathering of large crops of superior vegetable products without expenditure for fertilizers it is obvious that we shall have the art of fertilizing under our climatic conditions still to learn. We have, however, already entered upon large expenditure for fertilizers for fruit trees, especially those of the citrus family, and the world-wide problem of economical plant-feeding will reach all our producers, sooner or later, as each has the hungrier plants or the thinner soils. The old misconception of the pioneers that California climate and soil had some sort of beneficent inter-relation and inter-action which insured perpetual fertility, was merely a phase of the perpetual motion vagary, as applied to agriculture. It was a sort of reaction from the older view that California soil would produce nothing but winter pasture. Of course all these early notions have passed away. It is only a question of time when soil-building will be a regular California effort but on some lands, and for some crops, it may be a very long time before the problem will be pressing.

And yet it would not be truthful to convey the impression that fertilization is not undertaken at the present time. Reports made under the California Fertilizer law indicate sales of over 36,000 tons during the year ending June 30, 1917. There has been great progress during recent years in the utilization of natural manurial supplies which were formerly allowed to go to waste. The demand from orchardists has induced systematic search and traffic, and old accumulations from the stock farming of our first thirty or forty years have been put to good use, together with a considerable amount of artificial fertilizers. There is also a constant demand for the wastes of our towns and cities for gardening purposes. Our market gardeners have zeal for collecting the cleanings of city stables and our amateur gardeners, both in villages and on farms, make, as a rule, good use of the animal wastes which are available. They understand the advantage of intensive work and of bringing small areas up to maximum production, and they know that to raise large garden crops one must apply manure without stint, but our field production of staple vegetables is not intensive as yet, except as intensity is included in natural fertility. This being the case, the writer does not undertake prophecy. In a few years the progressive work which is now under way, especially in southern California, in trial of artificial manures for vegetable growing, will furnish object lessons for general guidance. Present purposes will be best served by offering suggestions as to the ways to turn natural supplies to best account.

Comparative Value of Animal Manures.—The excrements of different animals serve somewhat different purposes in garden practice because they act more or less quickly and are more or less stimulating to the plant. There is also warrant in carrying with the word stimulating the inference that in feeding plants, as in treating animals, that which is most stimulating must be used with the greatest caution. Both caution and economy prescribe that the manure which has the highest content of plant food should be used in less amount and more carefully distributed through the area of soil which the roots of the plant are expected to traverse.

The excrements of animals depend in composition upon the abundance and richness of the food furnished them. The following table is compiled from experiments and analyses made at Cornell University, and there is no doubt that the stock was well fed.

COMPOSITION AND VALUE OF FRESH MANURE FROM DIFFERENT ANIMALS.

Animals.	Nitrogen, Per cent.	Potash, Per cent.	Phosphoric Acid Per cent.	Value per Ton.
Cows	0.50	0.29	0.45	2.37
Horses	0.47	0.94	0.39	2.79
Sheep	1.00	1.21	0.08	4.19
Swine	0.83	0.61	0.04	3.18
Hens	1.10	0.29	0.47	4.22

The value is figured at the price agreed upon by eastern chemists as fair value for the ingredients as used in artificial fertilizers.

Value per ton is also conditioned upon the percentage of water in the manure. Hen manure has much less water even in a fresh state than that of cattle, and air-dried hen manure, free from earth, etc., is sometimes worth as much as $10 per ton, providing the hens are well fed. In this state air-dried sheep manure in large corral deposits in Fresno county has been found by analyses at the University of California to have this composition and value:

	Per cent.
Nitrogen	2.32
Potash	2.90
Phosphoric Acid	2.88

The material had only twenty-eight per cent of water and its value calculated at the agreed price of its ingredients is $10.95 per ton. Even when calculated at the same per cent of water, the California corral deposit has much higher value than the eastern sheep manure, because it has suffered less from leaching.

Garden Use of Concentrated Manures.—Hen, sheep and hog manure very much richer, as shown, than the same bulk of cow or horse manure. The safest way to use them is by composting with other materials, as will be described presently, but if it is desirable to use them alone, care should be taken in the distribution, as already stated. This can be assured by thoroughly mixing these manures with at least equal bulks of fine earth, when they will soon be reduced into a fairly dry and powdery state in which they may be readily spread broadcast on the land, or be sown by the drill, and be found a useful general manure for every kind of garden produce, if it is evenly scattered and not allowed to collect around the roots of single plants. A mixture which is good for all garden purposes can be made with 1,000 lbs. of chicken manure, 150 lbs. nitrate of soda, 600 lbs. fine bone meal, and 250 lbs. muriate of potash. Poultry manure should not be mixed with wood ashes.

Deterioration of Manures.—There are two ways by which animal manures lose valuable constituents: first, the escape of nitrogen by fermentation which sets free this element chiefly in the form of ammonia; second, the leaching out of soluble matters by exposure of the mass to copious rains. Both of these losses are practically prevented by drying of the manure. The local demonstration of this general truth is seen in the analysis just given of sheep manure which has passed through many years of exposure to the weather in an arid interior valley of California and still retains so much fertilizing value. Another means by which fermentation is reduced and controlled is by compacting the mass so that free access of air and free passage of water are prevented. This compacting is currently accomplished by the tread of the sheep confined by night in large numbers in small inclosure. The prevention of leaching in this case is also due to the fact that the local rainfall never reaches in any short period volume enough to accomplish percolation through the thick layer of manure to the soil. We have, then, in the case of a dry interior valley of California, all the conditions for the preservation of manure which the progressive farmers of humid climates secure by means of covered cattle yards, covered pits, manure sheds and other devices.

And yet manure will go to destruction in California as fast as elsewhere unless the conditions mentioned are secured. Loose piles of manure, except in the most arid localities, have, or subsequently receive, moisture enough to start active fermentation and will "firefang" and become nearly worthless in a very short time during our hot summer. Such loose piles thrown to the weather in the rainy season will be largely leached of their soluble matters wherever rainfall is considerable. Probably the easiest way to preserve manure in California is to allow it to lie in the corral during the summer, for there it is free from leaching rain, usually from June to November, and all its coarse straw, etc., dry and brittle, is reduced almost to powder by the tramp of the animals. If, then, this fine material is scraped up, spread and plowed in at the beginning of the rainy season it will readily ferment in the soil and all its value be retained, if the application is made to a heavy soil under a good rainfall. If the garden or field of fall vegetables is started with a good deep irrigation manure can be plowed in at that time, but otherwise the application should be made under the fall rains.

The winter-made manure should not be allowed to lie in the corral to be leached by drenching rain. It should be gathered frequently and applied fresh to the land, so that the leachings may go to useful purposes in the soil and the coarse material should be plowed in while there is still moisture enough in the soil to make the process safe and efficacious.

This easiest way to handle animal manures in California may do for ordinary farm crops, if the soil is heavy enough and moist enough to receive unfermented manure without danger to the crop from the loss of moisture, but it is not the best way to handle manure, either for field crops or for gardens. Manure for garden use should be most carefully treated to save all its richness and to render its coarse materials more readily available in soil-forming processes. In short, instead of preventing fermentation, manure for garden purposes should be put through a carefully controlled fermentation which is involved in composting.

Compost for Garden Purposes.—The term compost signifies a mixture of manurial substances and for garden use there should be collection constantly made of the voiding of the animals, trimmings of vegetables, the refuse of plants as the ground is cleared, the house wastes, and in fact everything of an organic nature which will yield to decay, and any available mineral wastes, like ashes, which contain plant food. If all these are added to the animal manure and treatment adopted which will promote the proper fermentation in it, the manure will assist in reducing the other materials to proper condition for garden use.

The conditions for such fermentation are adequate moisture accompanied with stirring and aeration enough to distribute the action evenly throughout the mass and to bring all the materials under its influence. There are numerous ways of accomplishing this, and each operator will probably have his own notions about their relative ease and cheapness.

Manure Tanks.—These are cemented, water-tight, excavations of various sizes. A Napa county farmer built one a few years ago which cost him nearly two hundred dollars, with all its appurtenances. It is thirteen by twenty and one-half feet in size, about six feet deep and exceedingly well built, having cement walls and floor, so as to be water-tight. The floor has a slant, inclining to a well at one end, where, with the aid of a wooden pump, the juices as they settle are raised to the top and poured over the mass to again percolate through it. Such a cistern might, perhaps, be made for less money now, but it is quite a question whether it is worth while making any such investment. Loss of liquid manure by leaching is prevented, but on the other hand it is apt to accumulate in such quantities in the pit that, unless the pit is roofed, the addition of the rainfall will result in the submergence of all the manure and this excludes the air and prevents the proper fermentation. The result is that there is great cost in excavating the water-logged material from the tank, a large amount of heavy and disagreeable shoveling and the manure not in the best condition after all.

Manure Pits.—Manure pits if excavated with one sloping side so carts can be readily backed in for filling, are cheaper than tanks and if they have a clay subsoil for a floor or can be puddled with clay on the concave bottom they will hold most of the liquid unless water flushing of the stable is indulged in. A large grower of beets and other roots for stock feeding in San Mateo county has for a number of years used this arrangement with satisfaction:

> I have a manure pit large enough to hold all the manure made in a year. A hole about three feet deep is dug out of the side of a hill. A sloping platform, up which all the manure is wheeled, raises it about four feet above the ground on the upper side, which gives a drop for the manure of about seven feet. When filled up to a level with the end of the platform, loose planks are laid as required on top of the manure. Thus by continually wheeling each day's manure over the older manure its solidity is insured, and all the manure made on the farm has to go up the said platform. After the cow stable is cleaned out, the lightest of the manure from the horse stable, bull stalls, etc., or any other absorbent, is put behind the cows, taking up fluids, and thus insuring a regular quality throughout the heap. Another important item added to the general heap is the hen manure and ashes, the latter being kept in a large tin, which, when full, is emptied into the fowl-house, and all goes in the manure heap together.

This use of absorbents prevents accumulation of excessive liquid and there is consequently little loss by leaching. The compacting of the mass prevents too free access of the air and fit conditions for slowly breaking down the coarse manure are assured. The addition of wood ashes which causes loss of nitrogen in open mixtures is innocent when covered into a mass of absorptive material.

Composting in Piles.—The method usually followed by market gardeners seems on the whole the most convenient and best for this climate, where the winter rainfall is, as a rule, not so heavy as to occasion much leaching, if the pile is of several feet in depth. It involves some shoveling, but it facilitates rapid curing of the manure and brings it into excellent condition for garden use. Stack the fresh manure in a pile several feet high. Then give it a thorough wetting from a hose and allow it to decompose for a few weeks. Then chop it down with sharp spades, mix thoroughly and stack it again; then wet it well once more, and after a few weeks it will be ready to put upon the field. This process of composting destroys all weed and other seeds, prevents the manure from burning, as well as the escape of volatile parts, especially when a small amount of loam is intermixed when stacking it. Compost thus made is suitable for the finest garden, at a moderate expense, and the work necessary will pay a larger profit than any other farm labor. Watching the moisture and using the hose, when the rainfall is not adequate, and thorough stirring and aeration of the mass, are the essentials of the process.

The manner in which the late Ira W. Adams handled manures involves correct practice:

> Clean up all the manure on hand just before the fall rains, putting the same on the land, and either cultivate it in or plow it under. What manure accumulates during the winter, pile in a snug heap some five or six feet in depth, and throw it over some three or four times during the winter to keep it from burning, as well as to thoroughly mix it and thereby hasten decomposition. Put horse, cow, hog, chicken, and every other kind of manure that can be had, all together.
>
> Never burn anything that will rot, but haul to the pile cornstalks, roots, and all squash, melon, tomato, and potato vines, etc., as well as weeds of every description, in fact anything and everything that will decay and make vegetable matter. Use fresh horse manure mostly to hasten the decomposition of said vines, weeds, etc., alternating as the heap is made. By so doing there will not be a weed seed left with vitality enough to germinate.
>
> It is well to have manure piles under a roof to avoid leaching during the longest and most excessive rains, but so situated that the rain falling on the barn can be easily conducted to the piles, giving them just the amount of water necessary and no more. After the rains are over, some water will have to be applied from time to time; and covering with very fine, dry earth will keep the pile from drying out during the long, hot summer, as well as cause it to retain most of the ammonia, etc., that would otherwise have evaporated and escaped. Late in the fall it will be found entirely rotten, cutting like old cheese.

Liquid Manure.—Liquid extract of animal manures is of great efficacy in vegetable growing if carefully used. It is made by filling a barrel with manure, pouring water on above and drawing it out below as it leaches through the mass. Another way is to have a barrel filled with water in a handy place and throw into it enough manure to make an extract of the right strength. No matter how it is done care must be taken not to have the extract too strong. This can generally be told by the color, which should not be darker than tea of medium strength. The quantity to apply in the hot-bed or the open ground must be learned by experience. Enough to produce generous and still vigorous growth is the rule. With plants to bear fruit like tomatoes much less stimulant can be used than with plants for foliage, for the stimulant always acts away from fruiting and toward leaf and stem extension.

Absorbents.—As has already been intimated, the free use of absorbents is very desirable both for valuable liquids, likely to leach away, and for gases which are prone to fly off. Probably the best absorbent for both purposes is ground gypsum, which is now very cheaply furnished from local sources in several parts of the state. It adds value of its own in addition to its absorbent properties. A very abundant material in an arid country is road dust. It, too, will take up both liquids and gases. In village gardens with paved streets and well-watered soil, sifted coal ashes act well in the hen-house and on the manure pile, and the cinders which are sifted out are a good foundation for permanent garden walks. The free use of the fine coal ashes for years kept the writer's fowls without a case of swell-head, rid the hen-house of all odor, and furnished many wagon loads of home-made fertilizer which is perfectly safe to use freely as the hen manure is diffused through quite a bulk of material. The effect of large use of these sifted coal ashes on an adobe garden well-nigh took the hatefulness out of it and made it into a loam delightful to put tools into.

Manure as a Mulch.—Market gardeners operating with heavy soils use immense quantities of barn-yard manure both composted with garden wastes and as fresh manure. The latter is largely used as a mulch or top dressing during the rainy season to prevent heavy rain from compacting the soil around the young plants and to get the richness of the manure by leaching. They use it in summer also to prevent surface evaporation and to prevent compacting the surface when the water is hand-thrown with scoop or pan from the ditches between the raised beds. This is to help small plants with their rooting; afterward they take water percolation from the ditch. The free surface use of fresh coarse manure to be afterward forked in, is safe on heavy clay, which the gardener is endeavoring to lighten up, but if coarse manure is used as a mulch on light sandy soil, it should be raked up and taken to the compost heap, as only thoroughly decomposed manure should be worked into such soil.

Of the services of a manure mulch, Prof. Rogers, of the University Farm, says:

> Well-rotted stable manure, free from coarse straw, should be put on to a depth of about two inches and scattered evenly over the beds. When planting onion, radish, turnip, beet or other seeds, scatter the manure on the beds immediately after planting. Where the vegetables have appeared above the surface the top dressing can be distributed between the rows. After the garden has thus been treated it will not need irrigating under ordinary conditions more than once a week, and except where the weed growth is bad hoeing will be a thing of the past. The manure not only has a physical effect, but it will enrich the soil and instead of the tops of the vegetables having a yellow, sickly color, they will become green and healthy in appearance. Water can be applied in the same manner as if the top dressing was not there.

Wood Ashes.—Coal ashes have no estimable manurial value; their effect is mechanical, just as is the effect of adding sand to clay, but wood ashes as well as plant ashes of all kinds, is intrinsically an excellent fertilizer, since it contains the soil ingredients required by all plants, even though in different proportions. The value of ash varies materially in accordance with the degree of heat to which it has been subjected when made. In general the hotter the fire, the less active will be the ash as a fertilizer.

The chemical composition of ashes varies considerably, according to the plants, or parts of plants, from which it has been derived; the smaller the wood, or the more of weeds or other herbaceous material there was in it, the more valuable the ash; but taking a broad average, a bushel (say forty-eight pounds) of wood ashes would, according to the ordinary valuation of the ingredients, be worth about twenty-five cents—counting on an average of five per cent of potash and two per cent of phosphoric acid. In general, ashes should be spread broadcast over the surface of the ground and allowed to be washed in by rains or irrigation, and not placed too near the plant. If plowed in shallow with stubble or weeds, the latter decompose very quickly, and the effect of both is thus improved and quickened.

The greatest benefit may be expected upon sandy and porous soils. On these "light soils" crops of every kind, but especially root crops and corn, will be benefited by a dressing of wood ashes. Thirty to fifty bushels to the acre of fresh ashes will be a full dressing, and three or four times that amount of leached ashes may be applied with permanent benefit.

Bone Manures.—To make bones readily available they may be treated with sulphuric acid and rendered into superphosphate, which is soluble. But sulphuric acid is a very dangerous agent to handle, and can hardly be commended for farm or garden use. Burning bones destroys their nitrogen and renders the phosphate even more insoluble. The best home treatment for bones is to crush them if it can be handily done, and then put them through the fermentation of the compost heap. The bones which do not break down under this treatment can best be buried deeply in the orchard to await the slow disintegration by the tree roots.

Commercial Fertilizers.—A discussion of the value and availability of commercial fertilizers is beyond the reach of this treatise. The vegetable grower should possess himself of a good recent book on the subject.* In connection with the different vegetables there will be mention of applications which have been serviceable, but a general formula may be cited from Voorhees, as follows:

A good basic formula for such market garden crops as asparagus, cucumbers, early potatoes, early tomatoes, onions, cabbage, cauliflower, celery, egg plants, melons, peppers, squashes, etc., may consist of:

	Lbs.
Nitrate of soda	100
Sulphate of ammonia	100
Dried blood	150
Ground bone	100
Superphosphate	450
Muriate of potash	150

From 800 to 1000 lbs. of this formula can be used per acre.

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*Such a book is "Fertilizers," by E. B. Voorhees, Macmillan Co., New York.

In addition to the foregoing, which should be well distributed through the soil before planting, additional surface scattering of nitrate of soda at the rate of 100 lbs. per acre may be made during the early growth of the plants.

Nitrate of Soda.—The nitrate of soda is the old reliance of gardeners as promotive of quick, free growth and the plant may be pushed early in its growth when perhaps temperatures are too low for full action of other supplies of nitrogen, which the soil may contain. Careful application should be made, after the seed has germinated, during the early stages of growth of the plant which it is desired to stimulate. The time of application does not depend upon the calendar but upon the ability of the plant to use it to the best advantage. An excessive application may kill the plants and even distribution is essential, either over the whole surface or along the row, at the rate of 200 to 500 pounds per acre, according to the ability of the plant to use it to the grower's advantage. The nitrate is distributed to the roots by the use of very little water; too heavy rainfall or irrigation may carry it away from them.

O. M. Morris of Los Angeles gives these hints for garden use of nitrate:

> A light application in furrows each side of the rows will stimulate more rapid growth. Probably the most satisfactory method is to scatter the crystals of nitrate of soda lightly along in the irrigating furrow after the water has been shut off, using five pounds to three or four hundred feet of row. Then turn the soil back over this wet furrow, when the nitrate will be quickly dissolved and will go directly to the roots. Blood meal applied in like manner will give similarly good results, as will also many of the commercial fertilizers with soluble ingredients.

Application must be made intelligently and sparingly at first until the grower finds how much he can use to secure best results with the particular plant he desires to push along.

CHAPTER IX.

GARDEN LOCATION AND ARRANGEMENT.

Several things should be considered in locating the farm garden, for much depends upon selecting: first, the best soil for the purpose the farm affords; second, situation with relation to protection, warmth and drainage; third, nearness to water supply for irrigation; fourth, nearness to the home and protection from intrusion. It may not be possible to combine all these points in a single situation, and then it may be advisable to make two locations, or, in making one, to sacrifice convenience to the more imperative conditions of exposure; soil and moisture.

Choice of Soil.—General considerations in connection with soils have already been given. Of course, for ease of work as well as for other considerations a rich loam should be chosen—the best that the ranch affords. As to grades of loam, the lighter should be chosen for the winter garden because of the better natural drainage and warmth and the short time in which such soils will take tools and seeds well after heavy rains. The heavier and more retentive soil will better suit the summer garden. Sometimes these two soils may be found beside each other in the same acre; sometimes the soil can be readily improved in these lines, as has already been explained, or small pieces at a distance from each other may be chosen if each has distinctive fitness.

Situation and Exposure.—Situation should be considered for warmth and protection as well as drainage, which has been mentioned. Though garden ground in general is most conveniently worked if it has just enough grade for the slow distribution of water, for winter and early spring growth an elevation out of the frosts of the low grounds and into the superior heat of the southerly slopes will be found of advantage. In addition to the ridge above, such protection from north and northwest winds as a windbreak of trees or farm buildings or a high fence will be valuable. There is great difference in the safety and speed of winter vegetables on benches and hillsides, as compared with the lower lands at their feet only a few rods away perhaps. Warm protected slopes are best for winter and the worst for summer vegetables. Shallow soil spread on porous rock is non-retentive and warm for winter growth, but it may be impossible, even with irrigation, to carry good succulent growth on it during the blistering summer heat. Then the deep loams of the creek borders and other level lands delight the gardener with the largest returns for the least water.

Nearness to Water Supply.—The summer garden should be near the water supply, if it be developed from home sources, or the water should be piped to it, which is almost equivalent to moving the reservoir to the garden site. Carriage of water in a flume entails losses by leakage and evaporation and earth-ditches are distressingly wasteful by evaporation and percolation. One often sees water started on its way from the home-site tanks toward a distant garden, making mud-holes and losing volume all the way. In many cases another well-outfit for the sole use of the garden would be a good investment.

Nearness to the Home.—If fairly good conditions exist near the home site, by all means locate the garden there. It will win the interest and profit by the attention of the house folks and will yield its supply directly to their hands in most cases. Besides, with the tools handy, spare hours now and then will be given to its working when the leisure is too short to warrant or incline one to walk to a distant patch. The time thus saved may almost keep the garden going in good shape. Then, a well-kept garden is an ornament and the ornamentation of our rural homes is not usually over rich.

Protection from Intrusion.—To be any comfort and gratfication whatever the farm garden must be protected from intruders. One of the chief objections to locating vegetable patches here and there in the best situations for special purposes lies in the trouble of excluding wild marauders of all sizes from a jack-rabbit to a deer and the whole range of domestic invaders from the pasture or corral. This fact alone compels many to forego vegetable planting except in the well-fenced house-yard. It is not difficult to inclose a few square rods with wire netting or with the woven fence of wire and lath, and driven posts—the whole to be rolled up and stored or moved to another inclosure as the progress of the season gives it new uses.

A home-grown fence is quite possible in California, using for pickets the southern cane or the Asiatic bamboos, both of which grow readily on moist land in this state. Mr. C. A. Maul of Kern county was recently reported to have completed the construction of a mile of fence, using these canes for pickets. His plan was this: Second-hand railroad ties were bought and split for posts. These were set a rod apart. With a machine that cost about twenty-five dollars, the canes were woven into a web, using six No. 14 wires for the chain. The canes were cut three and one-half feet long, the fence posts are four feet high and along the top of them a barbed wire is stretched, so that when completed one has a chicken or rabbit proof fence as well as a strong stock fence. This fence, Mr. Maul says, can be built for forty cents a rod where one raises his own cane. It is very durable, the cane becoming as hard as bone and never rotting; rabbits cannot gnaw it, and it will not ignite from burning grass near it as common pine fencing or lath will;

stock can see it and hence will not run against it; it can be made of any height desired, the canes growing as high as twelve to fifteen feet; it may be taken down, rolled up and moved without injury and at slight expense. In addition to their use as protective fences these woven canes and wire serve as windbreaks, sunshades, etc., as such may be desired for temporary service.

The Horse-Power Garden.—Although our foreign-born friends who do most of the market garden work in California retain their native predilection for hand labor and plan their gardens accordingly, it is advisable that farm vegetable growers should arrange to use as much horse power as possible. Both for this purpose and to facilitate furrow irrigation or seepage ditch irrigating, if the slope suits it, the garden should be somewhat brick-shaped, because of the greater work which can be done with the same or fewer turnings of the horse or team than on a square piece. At both ends there should be a roadway left for turning the team. The shape is equally adapted for flat or ridge cultivation.

In the horse-power farm garden there should, of course, be no permanent walks. If walks are desired, leave spaces lengthwise unplanted and uncultivated and smooth down the surface with a roller. Such arrangements, however, waste land and waste moisture, for the hard ground draws water laterally. It is better economy, therefore, to evenly cultivate the whole area. Lay out the plantings in straight rows for ease of cultivation, and either plant full rows of each vegetable or continue the rows with another kind which requires the same distance. Proper distances for each vegetable will be considered in subsequent chapters. It is convenient to make the distances multiples of some unit. For instance two feet between the rows is about the minimum distance for horse cultivation. Some growers, therefore, plant at two, four, six, eight, etc., feet distances: others start with three feet and proceed with six, nine, twelve, etc.—the latter for the largest running vines. This makes rows of the small, upright growers a yard apart, which is rather too great a distance ordinarily.

It is often a great convenience to have permanent distance stakes set close to the fences on the ends of the plot and placing them the accepted unit apart. It is easy to regulate distances by slipping the planting line over the two opposite stakes which give the desired separation. If one has a good horse and a good eye, he will, however, probably prefer to use a "marker" made with thills and plow handles properly fastened to a cross-bar eight or ten feet long and fitted with wooden teeth such distance apart as he adopts as his unit of distance between the rows. Starting, then, with a straight guide-line on the surface on one side, thre or four parallel lines can be clearly marked at one driving over. Following these marks with the garden drill, or with the hoe planting, very straight lines of seeding can be done in a fraction of the time needed to work with a line. But whether line or marker be used, it is desirable to rotate the plants year by year so that the narrow and wide row plantings shall change places on the plot, else one might be so supernaturally accurate that the rows would come everlastingly on the same lines, which would not be desirable even if the soil were somewhat displaced laterally by cultivation.

The Man-Power Garden.—With a soil either naturally or artificially light and mellow, as discussed in Chapter IV, there is possible a very satisfactory compromise between horse and hand work through the excellent wheel cultivators, seeders, etc., operated by a man while walking. They can be found in all garden, tool and supply stores and catalogues and should be used to replace slower and more laborious hand work in all save the smallest dooryard gardens, and even they are seldom too small to gain some advantage from the use of these appliances. Though they may be operated in very close rows it is much better for ease of cultivation and for the growth of the plants, also, that ample distances be given. C. M. Hoak, in the California Cultivator, gives good advice on this point:

> Do not make the mistake of putting rows too close together. With the exception of radishes, onions, lettuce and similar material, vegetables can be spaced in rows 30 inches apart. Double rows with the companion rows eight inches apart with the 30-inch spacing between is one of the most satisfactory arrangements which can be made to allow thorough cultivation. Try laying out your garden in this way, and every time you think you ought to water cultivate with a five-pronged cultivator or a wheeled plow. Your water bill will be lower and your vegetables better.

Arrangement for Succession.—It is a great convenience in arranging for due succession in the garden (which will be further considered in the chapter on planting) to give adjacent rows to vegetables which mature at about the same time. By this arrangement, say, half or a quarter of the garden lengthwise can be cleaned up at the same time and the whole section be at once replanted or plowed up for later planting or irrigating as may be desirable. Of course if early plantings for winter use are made in the same plot with plantings which will go into the summer, each should be in its own quarter of the garden.

Shade in the Summer Garden.—In arranging the summer garden in the interior heat, it is sometimes desirable to place low, tender-leaved plants like lettuce between rows of tall vegetables which afford it partial shade. Tall corn or pole beans may thus take the place of artificial screens which might otherwise be necessary.

VEGETABLE GROWING IN YOUNG ORCHARD AND VINEYARD.

This subject is usually discussed from the point of view of injury to the trees, and rightly so, because the trees represent the greater investment and the greater expectations, but the lowly vegetables have a point of view also and by their appearance they clearly declare that whether they hurt the trees or not they would like a better place on their own account. It is a fact that inter-culture of vegetables in an orchard is soon abandoned because the vegetables do not pay for the trouble and by the sight of them one is not surprised that they do not pay. It would probably be much better for trees, vegetables and owner if half an acre, if for home use, and larger area, if for market, should be kept free of trees and handled on a more intensive plan for the production of fine vegetables. When fruit prices were higher and orchard improvements the only avenue to high acre-valuation, it is not surprising that people tried to plant fruit trees everywhere on small tract purchases—even to making clothes-line posts of them, but now as other resources are receiving better proportional esteem, a small, first-class garden spot, worked up to the limits of its possibilities, should receive attention not only for constant money-saving and money-making, but as one of the most valuable improvements on the place.

There is no particular disadvantage or difficulty in growing vegetables in young orchards or vineyards providing conditions are right for it. Fruits and vegetables have been associated in gardens, probably, ever since Adam failed through giving too much attention to fruit. But the association of fruits and vegetables has been successful upon the garden policy of enrichment, irrigation, and the highest known culture. This is quite different from the proposition as it has arisen in California, which is to grow vegetables upon the orchard policy of cultivation for conservation of moisture and trust to the natural fertility of the land. It is not surprising that the soil often rebels at the double burden as beyond its strength and dictates its terms to the grower—by so much as you gain of one by so much you shall lose of the other.

It has, however, been shown in previous chapters on soils and irrigation that California has natural soils and situations which are quite comparable with the best conditions which intensive culture can produce in the gardens of older lands and, this being true, it is possible to draw upon their rich resources in the same way. It is quite possible, then, to grow good vegetables between young fruit trees and for a certain period it can be done without irreparable injury to the trees, providing the local conditions warrant the practice. These conditions may be thus summarized:

If the soil be of only average richness, the rainfall moderate to meager in amount, and no facilities for irrigation, it would be unfortunate to place any other burden on the land than the growth of the trees.

If the soil be not over rich and the rainfall heavy, but the moisture easily lost by percolation or evaporation, owing to non-retentiveness of the soil, and no irrigation facilities, give the trees all the ground and the most perfect summer cultivation possible.

If the land be rich, the rainfall abundant and moisture held well in the soil, or if irrigation can be made use of, it is fair to think of an inter-crop during the early years of the orchard, providing the crop can be profitably disposed of, its nature is such that no heavy draft is made on fertility, and the financial condition of the planter requires immediate return from the land, if possible.

It thus appears that an inter-crop is finally made to hinge upon the grower's necessities, and the inference would be that if the money is not needed immediately, it would be wiser to hold the whole strength of the soil as an investment on which returns are to be finally had in the increased growth and fuller fruiting of the trees in later years.

This views the matter from a commercial point of view and therefore in its most aggravated form. If it is merely a question of whether the home supply of vegetables shall be taken from the young orchard or vineyard, it is less serious and deserves a stronger affirmative.

In growing vegetables between the rows of trees or vines, much depends, of course, upon the time and the way it is done. If water can be applied between the rows late in the summer in such a way that it will not prevent the deciduous trees from going forward to their usual dormancy, or if the grower waits until the fall rains wet the ground sufficiently and then puts in his vegetables for late fall and winter growth without extending them too near the trees, he can make his winter garden, enjoy its produce, and plow in the debris so early in the spring that no appreciable injury will be done to the trees, unless he is on that line of light rainfall where every possible effort is demanded to receive and conserve all the water that falls. If that be the case he has to cultivate to conserve moisture both winter and summer and should not think even of winter vegetables in the orchard.

Perhaps the chief objection to winter vegetable growing is due to the fact that the crop is planted too late and is allowed to occupy the ground so late in the spring that the soil cannot be brought into fine tilth which is necessary to save moisture. Instead of this, the impacted ground on which the vegetables stood is turned up in clods which no amount of crushing will reduce to tilth and the orchard loses by defective cultivation more moisture than the vegetables consumed in their growth.

The summer growth of vegetables in the orchard is a more dangerous operation and whether it should be undertaken or not depends upon local conditions previously outlined. Perhaps a specific instance may enforce the point and show what may be taken as favored soil and moisture conditions. In the lower lands of the Santa Clara valley near San Jose there have been constant contributions to fertility by overflows from mountain water bringing leaf mold and other materials found in the deposits of "slum," which renew and keep up the fertility of the soil. Much of this land has been under cultivation forty years and upwards, and yet is known as garden soil. Much of this land is adobe, naturally remarkably productive, aside from its benefits from overflow. Such soils have proved able to produce, without apparent exhaustion, orchard trees and the crops that are grown among them. There is an abundance of artesian water for use when needed. It has been a common custom in this artesian belt, so noted for strawberries, to grow onions on the ridges between strawberry rows, and along the sides of other berry bushes. Onions are thus grown during several successive years until the ground is too crowded. Beets, carrots, peas, and other vegetables are sometimes grown among the berries. Crops of onion seed have been grown among the trees of young orchards without irrigation and the trees have done quite as well as when they had the ground all to themselves. Free use of the cultivator has kept the ground loose and moist, after one or two plowings. By irrigating in the fall, the ground can be plowed so as to start peas, potatoes, onions and other hardy vegetables for holiday sale, if the land is not liable to flooding in the late fall and has only light frosts until mid-winter.

Such land will carry all growths that can find standing room on it, and fruit trees will not be injured by the inter-cropping. Similar conditions are found on low, moist valley lands in many parts of the state, both in the coast and the interior valleys. The land has such wealth of plant food and moisture that summer weed-killing, which is not common in California, is quite a problem. Where weeds will grow in spite of ordinarily good summer cultivation, the land will stand almost covering with useful plants and it costs little more to grow them than to keep down the wonderful weeds.

But of course in inter-cropping all soils due regard must be given to maintaining fertility by manuring—even very rich soil will not always endure inter-cropping, and poor soil will soon make it unprofitable. Where hardy legumes like peas and brood beans can be grown to advantage their roots and straw add to fertility and they may pay their way thereby. But as a rule, inter-cropping should be undertaken, if at all, on a basis of generous manuring and ample water supply at low cost. The effort also demands definite knowledge of the handling which the crop requires—otherwise a man is apt to emerge from a speculative venture at inter-cropping with more wisdom than money.

CHAPTER X.

THE PLANTING SEASON.

The chapter on California climates as related to vegetable growing has already shown that there is really no closed season in the state except in the mountain districts. It is always time to plant something, if the moisture is available, for there is no degree of cold realized which endangers the hardier vegetables. It is true that in December and January in the regions of heavy rainfall, there is apt to be a cold, wet surface soil which does not give a hospitable welcome either to seed or seedlings, but even this can be overcome by using lighter soil at a little higher elevation or by the devices for raising the seed-bed unless one wishes to wait for February planting as is commonly done in such places. The antithesis of the December and January cold is the July and August heat and drought in the interior, but this, too, is conquerable by irrigation, with added shade for some tender-leafed plants, or by choosing moist, low land, of which California valleys both on the coast and in the interior have great areas. The conclusion of the whole matter is that California valleys and foothills are naturally fitted for almost endless succession of sowings and gatherings and such temporary unfitness as locally occurs is easily overcome by very simple cultural arts and provisions. Still there are best times for doing things for specific purposes and many of these can only be learned by local experience. An attempt will be made, however, to give hints to newcomers, or to the many who have not essayed vegetable growing and have thus neglected glorious opportunities, which will enable them to realize, it is hoped, some direction in which promising efforts may be put forth.

Seasonable Work in the Garden.—In view of the fact already emphasized that the planting season extends throughout the year and is regulated by local conditions and not by the calendar, it follows that other garden work constantly recurs, and it would be a hopeless task to attempt to specify certain times at which certain work should be done. The vegetable grower must use his own powers of observation and common sense, and not expect to find in print the injunction that on a certain day he must do a certain thing. It may be possible to make such prescriptions in more steady-going climates, but in our diverse local climates, which are either forcing or retarding, according to localities, and according to times of the year in the same locality, it is impossible to say just when a crop planted at a certain time should be hoed or cultivated, trained up or gathered, and the ground cleared up for other uses. All such acts will be omitted from our California garden calendar.

Let it be understood, rather, that the grower must be always on the alert to do certain things without suggestion from any one, viz.:

First: Stir the ground as soon as it will take tools well after the young plants have appeared above the surface, and thin the plants in the row to allow proper space for attaining good size. With some strong growing shoots from large, deeply covered seeds, it may be sometimes desirable to lightly harrow or rake the whole surface before the shoots appear: it is better to break off some shoots than to have them all under a crust. Light, mellow soil can, of course, be raked sooner after rain or irrigation than heavy soil—the latter must not be disturbed when sticky or sodden.

Second: Continue stirring afterward whenever the soil works well, for weed killing if there be any; if not stir the surface just the same.

Third: Continue stirring so long as the cultivator does not seriously injure the plant by breaking its stems and foliage, and then use the hoe carefully to prevent the ground becoming compacted near the stem in places not reached by the cultivator.

Fourth: Keep the condition of the plant constantly in sight and thought, to train or trim its growth to attain best results. Such treatment for each plant will naturally be noted in the place devoted to its special consideration later.

Fifth: Watch for the attainment of such degree of maturity as makes each plant most desirable for food purposes. The slack gardener is apt to allow his vegetables to become stale or over-ripe in the rows, and in that way miss their best estate.

Sixth: Gather promptly and dispose of each, either by eating or selling, when it reaches this condition and quickly clear away the remains of the growth for stock feed or for the compost heap. Do not allow the plants to stand for the purpose of gathering seed from the culls which are rejected at picking. Select the earliest and best specimens for seed if any seed is to be saved. It is, however, only in exceptional cases that the farm gardener should save his own seed. It is better to buy up-to-date varieties from those who make a business of selection and improvement of garden varieties. Keep the garden always clean and ready for something else. It is a mistake to let the garden lie neglected until the time for a spring revolution and upheaval, like that which eastern gardeners are forced to content themselves with. Of course, the error of stirring the soil when too wet must be carefully guarded against, but there is much besides digging involved in gardening.

Seventh: Irrigate, if necessary, and work the soil at once after cleaning up. Do not lose moisture by allowing the surface to become hard. No matter whether the ground is to be used for an immediate succession or whether it is to lie for some time, break up the surface and make it fit to receive water or retain water, as the case may be.

These timely and important acts will not appear in our calendar for the reasons first stated. They are always in order in California, and if a man has to be told more than once to do them, there are serious doubts of his ever having been called to be a vegetable grower.

CALIFORNIA GARDEN CALENDAR.

As shown in the chapter on climate, the timeliness of certain operations in California is not regulated by geography nor latitude, but by topography and environment, by moisture-conditions, either natural or acquired, and by the beginning and ending of the frost-free period. The broken country of the northwest quarter of the state, and the mountain elevations which are everywhere liable to snowfall, constitute regions which differ from the coast valley, interior valley and foothill regions both north and south, and are, therefore, to a certain degree out of our calculation, though an effort will be made to include some recognition of their practice. The outline to be made of timely work is intended to cover the state in all parts except where wintry conditions in greater or less degree intrude.

Our seasons, shading into each other without striking division lines, make it necessary to select a somewhat arbitrary point of beginning for a garden calendar. The point midway between the closing of one rainy season and the beginning of another is, by virtue of its drought-and-heat-effects on the rainfall garden, and its heat-effects even on ground kept moist by irrigation or underflow, the time when garden growth is about at its lowest point. It is also a time when preparations are to be made for the earliest sowing. The arrangement is somewhat arbitrary, as confessed above, but it accords best with all matters involved to look upon the month of July as the beginning of the California year in vegetable growing.

JULY.

On ground moistened anew by underflow from rising rivers or by percolation from irrigation ditches on higher orchard slopes, or on land cleared of an earlier crop, irrigated and well worked, it is possible to plant vegetables in July for late fall or winter use. String beans, beets, carrots, corn, peas, parsnips, potatoes, salsify, squashes, turnips, etc., will all come on rapidly if adequate moisture is furnished and frosts are reasonably late. Melons are also successfuly thus sown and with heat enough will mature in September from July planting. Near the coast, or in the interior, with shade, cucumbers, lettuce, radishes and other salads will thrive. Cabbage and cauliflower seed sown in proper beds or boxes, soon give plants for later setting which will mature for Christmas and on through the early winter; if not caught by frost, tomatoes will also come through from such a start.

AUGUST.

Corn and potatoes planted in August may still have time to reach satisfactory condition of maturity, except where frosts are expected early. Cabbage and cauliflower seed will give plants for proper winter succession; turnips on irrigated ground will also give winter crop. Onion seed may be sown for sets. August is a sort of divide in garden work. It is rather late to sow for fall use and rather soon to sow for winter use, and still August planting is practiced by many where local conditions take kindly to it.

SEPTEMBER.

Planting must still proceed upon moisture by irrigation, and planting for early winter use is still in order. The soil should be soaked deeply—to a depth of two feet, so that seedlings in the case of delayed rain may have moisture rising from below to keep them going. But irrigation must also be used as needed in addition to the initial soaking. Seeds should usually be covered a little more deeply than later in the rainy season. Peas started with irrigation and carried until rainfall is adequate will be ready for Christmas in regions where only light frosts occur, for peas are quite hardy. Cabbage and cauliflower should be sown in the seedbed for succession of plants—in some places they grow slowly and can be taken out for planting until February. Beets and salsify will start for use the following spring time and early summer, and potatoes will be "new" for the holidays. Lettuce and onions can be sown in place or plants may be grown in a seed bed for planting out after the rains come. In strictly frostless places, string beans, egg plant, and tomatoes are planted for very early crop.

OCTOBER.

It is still time to plant beets, cabbage, radishes, spinach, onions, lettuce, turnips and salsify for midwinter and spring use. Peas of early variety may still make the Christmas table in a favorable locality. Beans, egg plant, and tomatoes are still sown for early crop in frostless places.

NOVEMBER.

Still plant for succession. Peas, lettuce, radishes, cabbage, onions, beets, spinach, salsify, turnips. The coast valleys are now usually moist enough to carry all these hardy vegetables without irrigation, for late winter and early spring use. Asparagus roots are in shape for planting. Potatoes, in places with only light frosts, and beans, egg plant and tomatoes, in frostless places, are planted for early crop.

DECEMBER.

The higher lands of the interior valley are usually ready for the rainfall garden. Beets, cabbage, cauliflower, carrots, lettuce, onions, peas, radishes, spinach and turnips are hardy, though some roots sown at this time will in some places go to seed in the spring instead of enlarging. Potatoes are planted on slopes, well out of hard frosts. In northerly coast valleys the soil is often too cold and wet to make seed sowing wise. In such places the growth gets a poor start. This depends greatly, however, upon the character of the rainy season for that particular year.

JANUARY.

On warmer, drier valley lands in regions of light rainfall or on protected hillsides plantings of beets, cabbage, carrots, peas, turnips, lettuce, radishes and onions are usually wise. In colder regions lettuce and onions and radishes are hardy, and thrive if raised out of the wet, and cabbage, cauliflower, peppers, celery, tomato seed should go into seed beds to grow plants for later planting out. Asparagus, horesradish and rhubarb roots can be planted out in well-drained ground. It is the first great potato planting month for regions of light rainfall or on warm, well-drained slopes in regions of heavier rains. But on low valley lands in wet regions, January is often stormy and cold for open-air work, as has just been said of December.

FEBRUARY.

February is the great planting month, for everything but the very tender plants, like beans, tomatoes, peppers, the squash family, etc., can now proceed with assurance of adequate heat and moisture. It is the month for the dilatory man who has missed his earliest opportunities to fill the ground with seed of hardy vegetables, and it is the time when plantings in small frosty and rainy valleys, which have been deferred because the ground was too cold and wet to start seeds and plants well, may be confidently made. Successions and rotations are in order, as the fall-planted vegetables are cleared away. Early small plantings of string-beans, melons and cucumbers will often carry through or can be easily replanted if the frost catches them. Potatoes are widely planted and will seldom be

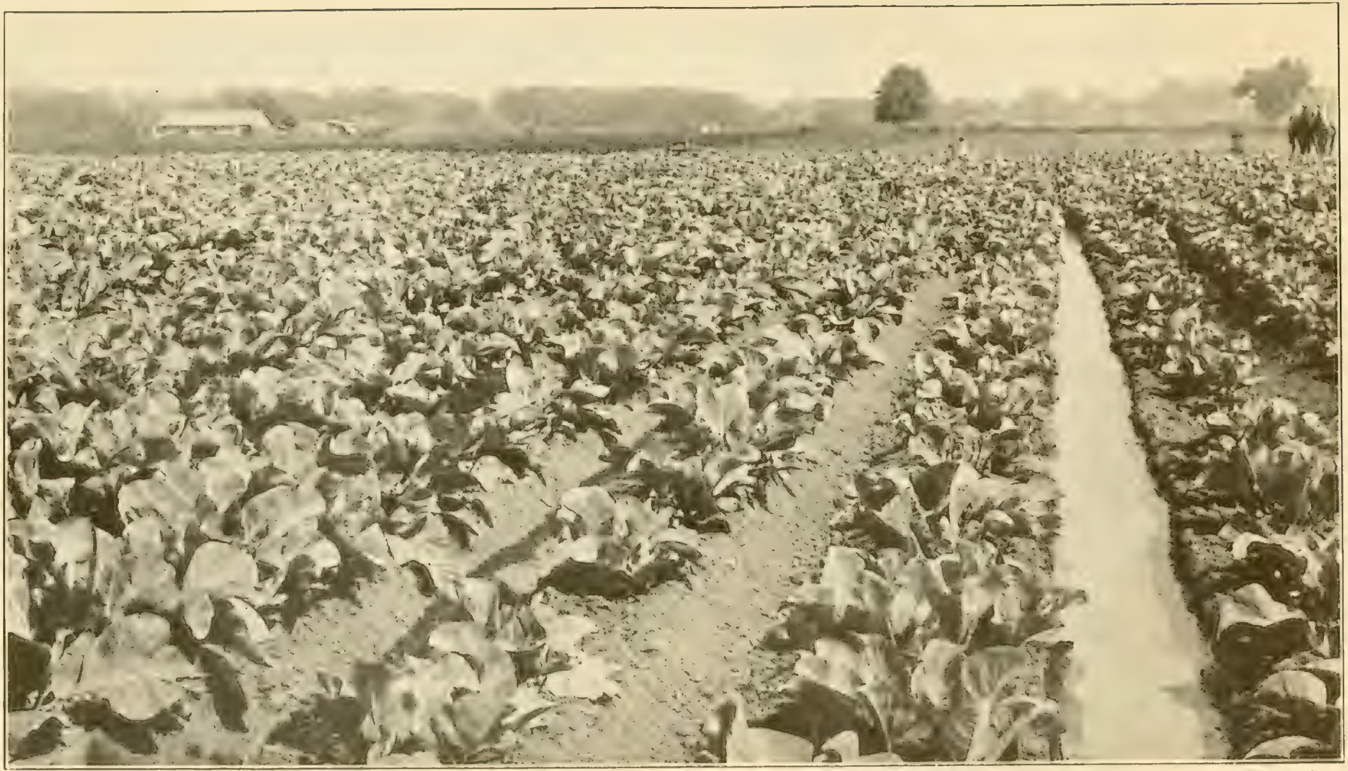

Photo Sacramento Co. Supervisors

Cauliflower field showing method of furrowing out and irrigating.—Page 166.

Univ. of Cal. Experiment Station

Pulling celery plants from seed-bed and transplanting to deep furrows in the field.—Page 180.

killed, though they may be cut back, except on low ground, which should be planted later. Chicory is sown, and sowing of sugar beets as a field crop for the factory, begins in February, on the warmer, drier lands.

MARCH.

Later plantings of all sorts of hardy vegetables for succession is pursued. The venturesome on higher, warmer lands try corn, melons, squashes, tomatoes, and continue planting beans. Cantaloups are planted for main crop in Imperial valley. Sugar beets are largely sown for factory use. Sweet potatoes should go into the hot-bed for slipping.

APRIL.

April is another month for succession planting of hardy vegetables, but it is getting late except where moisture is ample and late showers quite certain. Tender plants are out of serious danger except in especially frosty places. Beans can be confidently planted. Peppers, tomatoes, egg plant, sweet potatoes and other growths started under cover can be brought to the open ground. Corn, melons and squashes can be safely planted as field crops. The season's race is well along in its last quarter, and heat and drought have already made hay and are ripening the grain.

MAY.

Everything for which there can be assured ample moisture can still be planted in the moderate heat of the coast regions, but it is late for shallow-rooting plants to take hold in the interior heat, even with irrigation. Heat-loving plants, like watermelons, corn, sweet potatoes, etc., will grow grandly with moisture enough. On the coast, Lima beans, sugar beets for late crop, corn and roots for fall use will do well if well cultivated. All planting now which is well taken care of will carry its verdure and its crop to refresh the grower in the midst of the dry season. It is a time to seek and use moist land or to count on soon employing the fullest irrigation facilities the place affords.

JUNE.

June completes the garden year. It is the last chance to plant, and it is useless to plant at all except on land moist naturally or by irrigation. On such lands in the interior beans are largely planted and tomatoes for late crop on moist land are started from seed-bed plants. It is the last chance to get a second crop on land which has given produce. In the garden clear up all that has matured of the winter plantings, irrigate well, plow and quickly fine the surface and put in beans, beets, cabbage plants, corn, melons, potatoes, squash, tomato plants, and a succession of small truck, and be sure that they do not lack moisture, or their courses will be short and unprofitable.

TABULAR SHOWINGS OF TIMES OF PLANTING.

To afford the reader a condensed view of the facts noted in the foregoing suggestions for the months, tabular showings are prepared. These are not made from theoretical generalizations, but are prepared from records of actual practice which the writer has been collecting for the last forty years. The work of several hundred growers is condensed into the tables which follow. Separate showings are made for southern California and for the valley and foothill portions of the upper part of the state. It will be seen that they strikingly agree. There are practically frostless regions near the coast in southern California which are not found elsewhere in the state, although it is only with the tenderest growths that the difference becomes apparent. Other vegetables take about the same courses in early regions, both north and south. Still it is well to reduce the fact to a set of records such as these tables embody.

TIMES FOR PLANTING CERTAIN VEGETABLES IN VALLEY AND FOOTHILL REGIONS OF SOUTHERN CALIFORNIA.

	July[1]	Aug.[1]	Sept.[1]	Oct.[1]	Nov.[1]	Dec.[1]	Jan.	Feb.	Mar.	April	May[1]	June[1]
Beans	*	*	*[2]	*[2]	*[2]	..	..	*[3]	*[3]	*	*	*
Beets	*	*	*	*	*	*	*	*	*	*	*	*
Cabbage	*	*	*	*	*	*	*	*	*	*	*	*
Carrots	*	*	*	*	..	*	*	*	*	*	*	*
Cauliflower	*	..	*	*	..	*	*	*	*	*	*	*
Celery	..	..	..	..	..	..	..	..	*	*	*	*
Corn	*	*	..	..	..	..	..	*[3]	*[3]	*	*	*
Cucumbers	*	..	..	..	..	..	..	*[3]	*	*	..	*
Eggplant	*[2]	..	*[2]	*[2]	*[2]	..	..	..	*	*	*	*
Lettuce	*	*	*	*	*	*	*	*	*	*	*	*
Melons	*	..	..	..	..	..	..	*[3]	*[3]	*	*	*
Onions	*	*	*	*	*	*	*	*	*	*	*	*
Peas	..	..	*	*	*	*	*	*	*	*	*	..
Potatoes	*	*	*	*[2]	*[2]	..	*	*	*	*	*	*
Potatoes, Sweet	..	..	..	..	..	..	..	..	..	*	*	*
Radishes	*	*	*	*	*	*	*	*	*	*	*	*
Salsify	*	*	*	*	*	..	..	*	*	*	*	*
Spinach	*	*	*	*	*	*	*	*	*	*	*	*
Squash	*	..	..	..	..	..	..	..	*[3]	*	*	*
Tomatoes	*[2]	*[2]	*[2]	*[2]	*[2]	..	*[2]	*[2]	*[3]	*	*	*
Turnips	*	..	*	*	*	*	*	*	*	*	*	*

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[1] On naturally moist or irrigated land.

[2] Frostless situations near southern coast.

[3] Taking the chances of occasional frost and replanting in some places.

TIMES FOR PLANTING CERTAIN VEGETABLES IN VALLEY AND FOOTHILL REGIONS OF CENTRAL AND NORTHERN CALIFORNIA.

	July[4]	Aug.[4]	Sept.[4]	Oct.[4]	Nov.	Dec.	Jan.	Feb.	Mar.	April	May[4]	June[4]
Beans	*	*	..	..	..	..	..	..	*	*	*	*
Beets	*	..	..	..	..	..	*	*	*	*	*	*
Cabbage	*	*	*	*	*	..	*	*	*	*	*	..
Carrots	*	*	..	*	..	..	*	*	*	*	*	*
Cauliflower	*	*	..	*	..	..	*	*	*	*	*	*
Celery	..	..	..	*	..	..	..	..	*	*	*	..
Corn	*	..	..	..	..	..	..	..	..	..	*	*
Cucumbers	*	..	..	..	..	..	..	..	..	*	*	*
Eggplant	..	..	..	..	..	..	..	..	..	..	..	..
Lettuce	*	*	*	*	*	*	*	*	*	*	*	*
Melons	*	..	..	..	..	..	..	..	..	*	*	*
Onions	..	*	*	*	*	*	*	*	*	*	*	..
Peas	..	..	*	*	*	*	*	*	*	*	*	..
Potatoes	*	..	..	..	*	*	*	*	*	*	*	*
Potatoes, Sweet	..	..	..	..	..	..	..	..	*	*	*	*
Radishes	*	*	*	*	*	*	*	*	*	*	*	*
Salsify	*	..	..	..	..	..	..	*	*	*	..	..
Spinach	..	..	*	*	*	..	..	..	..	..	..	.
Squash	*	..	..	..	..	..	..	..	..	*	*	*
Tomatoes	..	..	..	..	..	..	..	..	..	*	*	*
Turnips	*	*	..	*	*	..	*	*	*	*	*	*

THE FROST FACTOR.

The intrusion of the frost period is a local limitation of the planting season. Each vegetable grower should keep records of frost occurrence for his own guidance in future operations and for the public benefit, for the government weather service is very anxious to get local observations on this point.

During the last decade the San Francisco office of the United States Weather Bureau has given particular attention to frost phenomena, including conditions of occurrence and prevention, and the publications by the Bureau comprise the best knowledge on the subject.

The discussion in the chapter on California Climate as Related to Vegetable Growing shows that weather conditions are everywhere dependent to a degree on local topography and environment, even though there are regional characters which must be understood. In this place it is fitting to emphasize especially the dates at which killing frosts have occurred in a large number of localities, because such dates are seldom accurately remembered even in the localities concerned. The table which we have compiled and arranged in our own way, according to districts, from data kindly furnished by the Weather Bureau, should be studied with the following points in view:

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[4] On irrigated or naturally moist low land.

First. The dates represent the first and last dates of killing frosts in each place during a decade. In most cases probably the dates are not in the same year. We wish to show the "worst ever" at each place.

Second. Obviously, then, frosts at such dates are not to be often expected, and planters may usually take the risk of planting somewhat earlier and having tender plants mature somewhat later, as will be discussed in the next chapter. At the same time large plantings for a main or standard crop should be generally held back for the local frost-free period which the dates in the tables supply for each place.

Third. Always remember, however, that there may be situations adjacent to the place where the record is made in which frost may be earlier or later, or both, according to the variations in local topography, exposure, etc., as explained in the chapter on Climate. There are also a few widely separated situations which may be considered almost, if not quite, frostless.

Fourth. The tables give the elevation in feet above sea level in each case. This factor does influence frost occurrence in a large way, but local frost phenomena are often determined by the relative elevation of situations in the same vicinity and by other conditions of topography affecting the movement of cold air and counter currents, perhaps, of warm air.

Fifth. Thus it should appear that after all the writer can do to help the reader determine what his planting practice should be with reference to frost occurrence, it still remains with the latter to do all that he can to understand his immediate spot of land through the teaching of his own observation and experience.

DATES OF SPRING AND FALL KILLING FROSTS AT PLACES NAMED.

Location and County	Elevation	Latest Spring	Earliest Autumn
Upper Coast Region			
Crescent City, Del Norte	50	June 19	Sept. 30
Eureka, Humboldt	64	May 1	Nov. 7
Upper Mattole, Humboldt	244	Apr. 26	Oct. 20
Ukiah, Mendocino	620	May 2	Oct. 16
Fort Bragg, Mendocino	74	Mar. 18	Nov. 5
Fort Ross, Sonoma	100	Mar. 21	Dec. 18
Cloverdale, Sonoma	340	Mar. 25	Nov. 2
Santa Rosa, Sonoma	181	May 10	Oct. 29
Peachland, Sonoma	220	Apr. 11	Oct. 18
Sonoma, Sonoma	30	Apr. 12	Dec. 2
Calistoga, Napa	363	May 1	Oct. 1
Napa, Napa	60	Mar. 30	Nov. 7
Upper Lake, Lake	1350	Apr. 23	Sept. 29
Sacramento Valley and Foothills			
Redding, Shasta	552	May 1	Oct. 17
Red Bluff, Tehama	307	Apr. 19	Nov. 7
Rosewood, Tehama	865	Apr. 12	Oct. 4

LOCATION AND COUNTY	Elevation	Latest Spring	Earliest Autumn
Sacramento Valley and Foothills —Continued			
Corning, Tehama	277	Mar. 26	Nov. 2
Chico, Butte	193	Apr. 10	Nov. 6
Durham, Butte	160	Apr. 4	Oct. 22
Biggs, Butte	98	May 10	Nov. 23
Oroville, Butte	250	Apr. 30	Nov. 23
Palermo, Butte	213	Apr. 7	Nov. 14
Fruto, Glenn	624	Apr. 4	Nov. 23
Willows, Glenn	136	Apr. 26	Nov. 28
Dunnigan, Yolo	65	Feb. 25	Nov. 24
Guinda, Yolo	350	May 1	Nov. 16
Woodland, Yolo	63	Apr. 26	Nov. 26
Davis, Yolo	51	Apr. 4	Oct. 22
Vacaville, Solano	175	Apr. 4	Nov. 24
Elmira, Solano	75	Apr. 4	Oct. 26
Suisun, Solano	20	Apr. 4	Nov. 13
Sacramento, Sacramento	35	Apr. 26	Oct. 17
Folsom, Sacramento	252	Apr. 11	Nov. 24
Wheatland, Yuba	84	Apr. 9	Nov. 7
Auburn, Placer	1360	May 2	Oct. 15
Colfax, Placer	2421	May 1	Dec. 5
Eldorado, Eldorado	1609	Apr. 26	Dec. 20
Placerville, Eldorado	1820	Apr. 28	Nov. 28
Georgetown, Eldorado	2650	May 1	Oct. 15
Nevada City, Nevada	2580	May 30	Sept. 29
North Bloomfield, Nevada	3200	May 22	Oct. 1
Jackson, Amador	1900	Apr. 28	Oct. 14
Central Coast Region			
San Francisco, San Francisco	207	Mar. 27	Dec. 18
Oakland, Alameda	36	Feb. 15	Dec. 15
Berkeley, Alameda	320	Feb. 19	Dec. 14
Niles, Alameda	87	Apr. 29	Oct. 17
San Leandro, Alameda	50	Mar. 28	Nov. 24
Livermore, Alameda	485	Apr. 12	Nov. 9
Menlo Park, San Mateo	64	Feb. 13	Dec. 18
San Jose, Santa Clara	95	Apr. 9	Oct. 22
Santa Clara, Santa Clara	90	Apr. 9	Nov. 24
Los Gatos, Santa Clara	600	Mar. 8	Dec. 9
Gilroy, Santa Clara	193	May 11	Nov. 6
Santa Cruz, Santa Cruz	20	Apr. 1	Nov. 23
Laurel, Santa Cruz	910	Mar. 12	Oct. 24
Aptos, Santa Cruz	102	Mar. 31	Oct. 31
Watsonville, Santa Cruz	23	Apr. 8	Sept. 22
Hollister, San Benito	284	Apr. 22	Oct. 17
Salinas, Monterey	40	Apr. 1	Nov. 21
Soledad, Monterey	183	Feb. 13	Nov. 30
San Ardo, Monterey	236	Apr. 10	Dec. 9
San Miguel, San Luis Obispo	616	Mar. 8	Oct. 22
Paso Robles, San Luis Obispo	800	Apr. 26	Oct. 30
San Luis Obispo, San Luis Obispo	201	May 18	Oct. 18
San Joaquin Valley and Foothills			
Antioch, Contra Costa	46	Feb. 1	Dec. 5
Lodi, San Joaquin	35	Apr. 9	Oct. 18
Tracy, San Joaquin	64	Mar. 14	Nov. 24
Milton, Calaveras	660	Apr. 7	Nov. 29
Mokelumne, Calaveras	1550	Apr. 28	Nov. 17

Location and County	Elevation	Latest Spring	Earliest Autumn
San Joaquin Valley and Foothills —Continued			
West Point, Calaveras	2326	June 15	Oct. 7
Jackson, Amador	1900	Apr. 28	Oct. 14
Merced, Merced	173	Mar. 28	Nov. 28
Fresno, Fresno	293	Mar. 31	Nov. 11
Selma, Fresno	311	Mar. 31	Oct. 20
Kingsburg, Fresno	301	Apr. 28	Dec. 23
Hanford, Kings	249	Apr. 29	Oct. 25
Visalia, Tulare	334	Apr. 11	Nov. 16
Lemon Grove, Tulare	600	Feb. 16	Dec. 9
Porterville, Tulare	461	Mar. 10	Nov. 26
Tulare, Tulare	274	Apr. 11	Oct. 20
Dinuba, Tulare	335	May 2	Nov. 27
Southern California			
Santa Barbara, Santa Barbara	130	Mar. 18	Nov. 30
Santa Paula, Ventura	350	Feb. 16	Dec. 12
Los Angeles, Los Angeles	293	Mar. 9	Dec. 13
Anaheim, Orange	134	Apr. 17	Dec. 12
Riverside, Riverside	851	Apr. 2	Nov. 12
San Jacinto, Riverside	1550	Apr. 8	Nov. 25
Redlands, San Bernardino	1352	Apr. 9	Nov. 24
Escondido, San Diego	657	Mar. 18	Dec. 7
Poway, San Diego	460	Feb. 15	Nov. 18
El Cajon, San Diego	482	Mar. 14	Nov. 19
Campo, San Diego	2543	June 17	Sept. 17
Mountain Regions			
Sisson, Siskiyou	3555	July 6	Sept. 13
Cedarville, Modoc	4675	June 24	Aug. 30
Susanville, Lassen	4195	June 22	Sept. 8
Laporte, Plumas	5000	July 6	Sept. 6
Greenville, Plumas	3600	June 11	Aug. 20
Boca, Nevada	5531	May 1	Oct. 2
Summerdale, Mariposa	5270	June 15	Sept. 25
Lick Observatory, Santa Clara	4209	May 25	Oct. 2
Tehachapi, Kern	3964	Apr. 11	Nov. 20
Cuyamaca, San Diego	4543	July 11	Sept. 5

The general reader, after studying the foregoing data, may conclude that in nearly all the valley districts of California there is little difference in the length of the absolute frost-free period; also that elevation influences temperature similarly in all parts of the state. At elevations below 1500 feet, which is the point at which foothills begin to shade into mountains, there are about two-thirds of the whole year in which even the tenderest vegetation may be considered practically safe from injury from frost, and particular situations in which the frost-free period is even longer. On the other hand, there are mountain valleys, with good soil and sunshine and ample total heat for vegetables, in which tender plants must be always protected, because frost may occur every month in the year.

The Endurance of Different Vegetables.—The degree of cold which plants will survive depends upon several considerations and conditions, involving state of air, moisture and of the plant itself, which makes it impossible to fix the injury point of a plant definitely. There is, however, practical value in the following compilation made from reports by Pacific Coast growers as to the effect of our style of low temperatures, the temperatures being given as nearly as possible those in contact with the plant itself.

TEMPERATURE AT WHICH CERTAIN PLANTS ARE LIABLE TO RECEIVE INJURY FROM FROSTS.

Plant	Degrees Fahrenheit	Plant	Degrees Fahrenheit
Asparagus	29	Beans	31
Cantaloups	32	Celery	28
Cucumbers	32	Onions	28
Potatoes	30	Sweet Potatoes	31
Spinach	21	Squash	31
Turnips	26	Watermelons	31

Not Always Freezing at 32 Degrees.—In connection with the endurance of vegetables, it should be noted that in parts of California freezing effects are not produced by a temperature of 32 degrees. This is in accordance with a deduction from wide studies of frost occurrence by P. C. Day, Chief of Climatological Division of the U. S. Weather Bureau, as follows: "Cool nights are a feature of all arid regions, due to intense radiation made possible by the generally clear skies and lack of moisture in the atmosphere. As a result of these conditions the temperature in the early morning hours may frequently reach the freezing point, but its continuance may not be for a length of time sufficient to injure the plant structure; in fact, owing to the dryness of the air, frost does not always form with a temperature of 32 degrees or even several degrees lower, and in addition plant life subjected to such variations in temperature becomes more hardy and lower temperatures are required to cause serious injury. On the other hand, in the more humid regions the radiation at night is less rapid, the nights as a rule are not so markedly cold, plant life is less hardy, frost forms readily at the freezing point, the same degree of cold is often protracted over much longer periods of time, and vegetation is, therefore, more seriously affected."*

SUCCESSIONS AND ROTATIONS IN CALIFORNIA GARDENS.

Naturally, an all-the-year growing season suggests constant use of the ground and the possibility of turning the soil over several times in the course of the year. This can be done by quick revolution, like the following:

> Where water is handy two, three, or even four crops can be grown on the same ground in the year. Start April 1 and sow the plot to lettuce, and with

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*Frost data of the United States Bulletin V, U. S. Weather Bureau, 1911.

proper cultivation it will mature in two months. Resow with turnip-radish, which is a good summer variety. These will be fit to use in three weeks, or by the first week of July, when the ground will be ready for late cucumbers which will occupy the ground until the first frost, or till the nights become too cold for them to fruit. Now plant to carrots, beets, or onion sets, and any of them will be ready for use in February or March. Here we have four crops within twelve months, and no two of them occupying the ground at the same time. There are other combinations that would do as well.

Though this rapid work is quite feasible, as shown, and many plants can enter into such combinations, the two crop plan will probably be as fast movement as most farm gardeners will keep up with, and that consists in fall sowing of hardy vegetables for winter and spring use, followed by spring planting of tender vegetables for summer and fall use. Occasionally there will be intervals in this rotation for a third or catch crop of lettuce, radish, etc., which takes a very short time. This will be a vast improvement on the present popular conception of gardening possibilities, and if the hint of a fall crop of tender vegetables like melons, beans, corn, etc., planted in July to come on fast in the heat, followed by fall planting of the hardy list for winter use, these two crops will be gained before the outbreak of the usual "garden fever," which rallies all garden forces in February and March. The agencies to demonstrate this broader conception of our gardening possibilities are Will and Work and Water, to which allusion has been made in a previous chapter.

Family Garden Programmes.—It will surprise anyone who carries out rapid succession of plantings to see how much desirable food can be secured from a very small area. An enthusiastic gardener at Lakeside, San Diego county, reported that his garden of fifty feet square supplied enough vegetables, excepting potatoes, for a large family, and required less than half a day's attention during a week. He grew the following vegetables, planting each month in the year as follows:

January—After the 20th, turnips, cabbage seed, carrots, lettuce, peas.
February—Radishes, beets, salsify, spinach, onion seed or sets.
March—Potatoes (in field), turnips, cabbage, lettuce, peas, cabbage plants.
April—Cucumbers, watermelons, muskmelons, squashes, tomato plants, radishes, beets, salsify, corn, beans, sweet potatoes, cabbage seed.
May—Carrots, lettuce, peas, onion seed or sets.
June—Radishes, beets, beans, corn, salsify, cabbage plants.
July—Carrots, lettuce, cabbage seed.
August—Potatoes (in field), corn, beans, radishes.
September—Cabbage plants, peas, turnips, salsify, carrots.
October—Beets, beans, onion sets, lettuce.
November—Turnips, spinach, salsify.
December—Winter radishes, peas, lettuce.

He has the advantage of a very short period of frosts, and light ones at that. He plants in rows eighteen inches apart, irrigates his garden every ten days in trenches and cultivates twice a week. In favorable seasons he has natural moisture from November to April or May. If the rainfall is light he cultivates twice a week.

Another arrangement for succession is that practiced by a vineyardist in the Santa Cruz mountains, who grows vegetables in his vineyard. He plows one furrow in the center, between the vines, manured in the furrow and covered with a furrow plowed each side. The bed thus formed is planted in November with a row thickly sown, of American Wonder Peas, covered with the rake, making a smooth place where, about four inches from the peas, are planted cabbage, Chinese Rose Winter radishes, onions, lettuce and turnip seed, mixed. Other sowings, adding carrots, beans, etc., are made, according to the weather, until May. In February he gathers radishes and lettuce; in March, peas. He sells or gives away bushels of lettuce and radishes, and has enough to supply a big family from March 1 to July. As late as November he gathers beets, carrots, turnips and string beans. He has the advantage of a larger winter rainfall, and conserves moisture by cultivating between the rows every week in dry weather.

CHAPTER XI.

PROPAGATION AND PLANTING.

From what has been said of the favoring conditions in California for open air work and freedom from low temperatures, it may be rightly inferred that the higher arts of propagation involving the use of acres of glass and the most approved heating devices, are not to be found in California. The forcing of vegetables which is now commanding such wide effort and investment at the East is only undertaken to a limited extent, and although it is increasing with our advance in population and wealth, it will always be menaced by the open air work, both in average situations and in frostless localities which are, at present, only worked up to a fraction of their capacity. Forcing is, however, accomplished with much less expensive structures and heating arrangements than at the East because only slight drops in temperature are to be overcome. We have also a decided advantage in the large percentage of winter sunshine. Forcing is, therefore, relatively cheaper than in wintry regions and there may be, ere long, an important industry. Of course the same general conditions which discourage forcing with us also make elaborate and expensive arrangements for growing tender plants for subsequent planting out, unnecessary. Not only do hot-beds of the scantiest construction and covering answer local purposes, but even their heating materials have to be toned down by more slowly fermenting intermixtures and by freer entrance of air, lest the growths be overforced. Often, as will be described presently, a little bottom heat, with very slight covering above, is all that conditions require to bring forward and protect tender seedlings until it is safe for them to take their chances under kind skies.

TESTING SEED BEFORE PLANTING.

One should know the viability of seed before risking his labor upon it. The following is a current account of a simple test suited to the needs of amateurs:

> Take two dinner plates and pieces of cotton flannel. Boil them both to destroy any mold spores or fungi they may contain. Upon an up-turned plate place a layer of moistened cotton flannel. On this lay the seeds to be tested, of the small seed say a hundred, and half the number of large seeds will do. Over this place another moistened strip and cover with a similar plate. If more than one variety of seed is to be tested at one time another strip may be laid on top of the first set, the seed placed and covered as before, using two pieces of cloth for each variety. This gives the seed an aerated and more or less sterilized germinating bed. Set the plate in a somewhat darkened place where temperature of 70 to 80 degrees F. during the day and, if necessary, less than 50 degrees F. during the night, may be maintained. The length of

time required for germination will depend largely upon the nature of the seeds, from six to ten days usually being required. Where only a small percentage of the seed fails to germinate the grower may provide against a poor stand with a heavier seeding. Where the percentage germinating is small it is usually desirable to try for a better lot of seed before planting.

GROWTH FROM SEED IN OPEN GROUND.

Adequate heat and moisture are essential to germination and subsequent growth. The preceeding chapter has shown at what times these factors are present in California soil, either by nature or artifice of the planter. Heat is almost always adequate for the germination of the seed in common vegetables, in well-drained surface soil in the California valley regions. Even in our frosty weather, the day temperature of the soil is adequate for germination except, perhaps, during the colder storms and seldom does our rain have too low a temperature. Even in this it is not so much the matter of germination as of conditions inhospitable to the subsequent growth of the germs. It makes little practical difference, perhaps, whether the seed is killed or the germ perishes after starting. But the death of either seed or germ is more often due to moisture lack or excess, than to temperature conditions. For this reason a sowing may go for naught if seeding is done in the fall without thorough moistening of the soil by irrigation or rainfall, or the same disappointment may follow sowing even seed of hardy plants in certain localities in December and January in years of heavy rainfall. For these reasons it is all-important that the vegetable grower should carefully observe his local conditions of soil, heat and moisture and arrive at proper deductions from his own experience as to what acts he should perform under his ruling local conditions and the peculiar phases of the weather of the particular year in which he is acting. And then a vegetable grower, in garden practice, which involves succession of small areas, must be enterprisingly venturesome. He must take some chances of losing a sowing or planting and of renewing it, and he should always keep adequate supplies of seed or seedlings at hand. It is a great deal better to lose a sowing than to set up some arbitrary dead-sure date for sowing; for with such a policy he will never have anything early, and perhaps never anything profitable. Field work for staple vegetables is another proposition, but field work for shipment of early stuff is always attended by some risk, for the grower has to venture everything on doing the best he can to be safe and early, but to be early at any rate.

Although this is true it must be always remembered that nothing is gained in working the soil or sowing the seed when the soil is not in condition to work well. Some results of this bad practice have been mentioned in other connections and they are deplorable, especially in the heavier soils. It is especially an error of judgment in seed sowing to suppose that any time can be gained by sowing early upon an unfit seed bed. Even if a fair stand should be secured there will be handicaps upon the plants all through their course, and a somewhat later planting with the soil in good condition will probably surpass them both in time and quality.

There is often advantage in soaking seed overnight in tepid water. The lighter the soil and the later the sowing the greater benefit will accrue from this method of hastening germination. When the wet seed is difficult to handle, or when it is to be used with a seed-drill, sift some fine ashes over the seed. This will take up the surface moisture and allow them to run through the drill easily.

Arranging Moisture Conditions for Germination.—In addition to the greater undertakings described in the chapters on irrigation and drainage, there are little acts which are of the utmost importance in securing moisture conditions favorable to germination and growth.

First: Seed covering. Darkness is favorable to germination of most seeds, but covering is primarily for two other purposes. One is to assist the seedling in its anchorage and root penetration, but the more important is to insure it moisture. There can be no positive rule for depth of sowing. Five times the diameter of the seed might do at the best of the season in the best garden soil, but this depth would be too great for some seeds in some soils in the rainy season, and far too shallow for the same seed and soil in the dry season. On all soils the rule must be shallow sowing, if large rainfall is characteristic of the region; deep sowing if scant rainfall is to be expected; shallow sowing early in the rainy season; deep sowing near its close; shallow sowing on the heavier soil; deep sowing on the lighter soils. Late in the season the surface layer which is air dried in spite of stirring, does not count as depth at all. It must be brushed aside and the seed sown in the moist layer beneath whether the sowing is done by hand or with a seed drill.

Later cultivation will level the soil back around the plant stem to assist in retaining moisture below. Conforming to this condition, the larger summer-sown seeds should be sown in the light soil of the interior valleys at four to six inches deep—twice or three times the depth prescribed for the seed in humid climates or in the humid side of our own climate. Seeds sown in hills can stand deep planting better than when sown singly, as they seem to join their strength in uplifting the weight of soil above them.

Second: Soil firming. This is another act which aids the seed in other ways, but is primarily for moisture furnishing. A seed thrown into a loose surface layer may germinate and perish for lack of moisture and soil-contact or it may lie unquickened until a footstep or a shower compacts the earth about it. It may thus lie half a year in California. Many amateurs are much too kind in their intent and too cruel in their method, by making the surface as loose as possible and then gently placing the seed in the loose layer. It is better to jump on it with both feet. Whether it be done by direct tramping or by tramping a narrow board placed upon the sown row, or tamped down with a block with a long handle, or by using the garden or field roller, or by flat slaps with the back of the planting hoe, it matters not; it is only essential that the firming of the inclosing layer should be given unless immediate water settling of the ground is anticipated. And this firming is conditioned in degree upon soil and season just as depth of covering is, viz.: light soil or late in season, heaviest firming; heavier soil or early in season, lighter firming. The reason for firming is the restoration of capillarity to the loose layer, consequently adequate moisture supply to the germinating seed. But when this capillarity has served its purpose and the root has penetrated the permanently moist layers below, this capillarity near the surface must be destroyed by cultivation and the surface layer again loosened so that it will not transmit moisture. Therefore, as prescribed in an earlier, chapter the hoe or cultivator must be started as soon as the young plants can be seen, and in some larger seeds where the firmed layer has been crusted by a shower a light harrowing or raking may be desirable to release the shoots from the too compact covering which has come over them.

Third: Soil opening. The converse of firming the soil about the seed is drying of the surface soil when unexpectedly heavy rains have come and the water does not percolate rapidly enough to bring the surface layer into good condition for growth. In such an event seed can often be saved from rotting by the light raking or harrowing or cutting with a disc, to allow the air to assist drainage in relieving the surface layer of its excess. The wisdom of this course is always conditioned upon the character of the soil. A sticky soil might be more harmed than the seed would be helped by it.

Fourth: Mulching. The use of a light mulch of chaff or corral-scrapings or rotten straw or other fine, loose material is of value in garden practice if it does not occasion too great cost or labor to procure or prepare it. The larger the seed the thicker the layer may safely be, and with the mulch, shallower planting and probably quicker germination, is possible. The mulch lessens evaporation from the surface and thus gives the seed a surer supply; it also prevents puddling of the soil surface by pelting rain drops and keeps the particles both moist and loose for the thrust of the shoot. A mulch also makes it much safer to sprinkle the bed if rains delay. In garden practice it can hardly be too highly commended. On heavy soils sawdust or sand can be used for this purpose if they are the most available materials. Discussion of mulching from other points of view is given in Chapter VII.

Fifth: Irrigation. Starting seeds by irrigation on soil that has good capillarity and lateral percolation (or "seeps well" as the common phrase is) releases one from several of the injunctions just laid down. The covering should be shallow, as the moisture will rise to the surface; little firming needs to be done, for the water will settle the soil, and when the moisture is ample, stopping the supply will quickly allow the escape of the surplus. It may sometimes be desirable to use a light mulch to protect the surface from baking and give the seedlings a few days' more growth before it is necessary to stir the surface. Seed starting in this way with the raised beds and permanent ditches and the ridge irrigation system, all of which have been described in the chapter on irrigation, is very satisfactory. The application of it to various vegetables will be given in the treatment of each. Where the seeds are to be started by the furrow system on land that will draw water well laterally, the seed can be sown in shallow trenches, leaving the seeds barely covered. Then irrigate by turning water into shallow irrigation trenches made some twelve or fifteen feet apart. Let the water soak through and completely moisten the surface until it has spread across all the seed trenches, and until the little clods are broken down and dissolved. The seeds are thus well covered and enabled to sprout and come up before the soil is dried out. Subsequent cultivation levels the ground, giving the seedlings sufficient depth of covering and new furrows are plowed for later irrigations. This is only one of many ways by which seeds can be started by irrigation.

GROWTH FROM SEED UNDER COVER.

This broad title is used to include about all that is done in California except under the sky cover. In the chapters on the different vegetables, which will follow, there will be mentioned special propagating methods employed with each, but in this place a few protecting and promoting arrangements will be described for the benefit of beginners in garden work.

Seed Boxes.—Seed boxes are the simplest arrangement for starting seedlings for subsequent planting out and in most amateur gardening in this climate they will comprise about all that is necessary in the way of construction, because, as will be seen later, it is very easy to give them a little bottom heat if the grower desires, but they can be largely used without any. The chief advantages of starting seedlings in boxes instead of the open ground are the ease with which the seed boxes can be carried under protection from cold, beating rains or frost, or protected from hot, drying winds or too intense sun heat, and the convenience with which moisture conditions can be regulated by covering and light sprinkling.

There are no particular dimensions to be observed in making seed boxes, except that they should not be too large to be easily lifted and carried with their contents. The cases which enclose two five-gallon cans of coal oil, sawn in two lengthwise so as to make two wide, shallow boxes, serve an excellent purpose. It is more convenient to have all the boxes of the same size than to use odd sizes, in case it may be desired to group the boxes in a hot-bed or otherwise for heat and covering. Be sure that the bottom has ample openings for drainage—either cracks or bored holes. The soil-layer in the boxes should not exceed three inches in depth. In ordinary amateur practice a good soil for these boxes can be made by taking good rich garden soil as a basis. Add sand and, if possible, the light mold from under an old straw stack, leaf mold, finely powdered rotted manure, or something similar, until you have a rich, friable soil. No definite rule can be given for mixing, except that the prepared soil should hold moisture well, have no tendency to cake, and never crack in the sun.

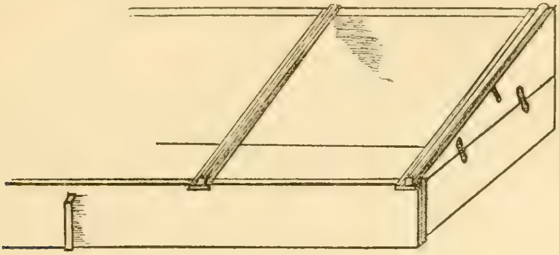
Fill the boxes, and, with a small board, press the soil closely and evenly, so that it will retain moisture. The seeds should then be sown quickly and evenly over the surface or in lines, and pressed down by a smooth board into the soil, so that the seed, be it large or small, will form a level surface with the soil. This being done, the same prepared soil should be sifted evenly over the top, just enough to cover the seed, if it is small, and but little more if it is larger. Again press this layer of soil which has covered the seeds gently with the smooth board.

It is a great help to seed to have the surface again covered with a light material that would hold moisture, such as dry moss, or powdered vegetable matter of any kind which is light and will hold moisture. This should be rubbed through a sieve over the seed boxes, just thick enough to cover the soil (not more than-one sixteenth of an inch). It is very beneficial in the germination of the seed, as with such a top-dressing one watering with a fine rose watering-pot will keep the soil moist enough usually until the seeds come up. It is a great mistake to be continually watering seeds after they have been sown. The rule in all these things is never to water until brushing the litter from the surface indicates that the soil is dry.

A Cold Frame.—The arrangement which comes next to the seed box in simplicity is the cold frame. It is simply for the purpose of concentrating sun heat and protection from low temperatures and heavy rain storms. It is a convenient receptacle for the seed boxes already described, or it may be put over seeds sown in the ground—the soil being prepared to receive the seed in about the same way already described for filling the boxes. The frame is made of inch boards, the front board about twelve inches wide, the back board or boards eighteen inches wide and the sides sloping about six inches to meet the widths of the front and back boards. The frame is usually made three feet from front to rear (for convenience in working from the front, but can be of any length desired). For large scale work, the frames are usually made larger—say four or five feet wide and twenty feet long. This frame is covered with glazed sash or cloth frames or lath frames or first one and then another, according to the amount of protection and heat or of shade desirable. The arrangement is called a "cold frame" because no provision is made for bottom-heat. There are many modifications of the cold frame; lath or slat houses or lath covers for beds with raised edging boards, etc., etc., are all on the cold frame principle, and in this climate, where so little increment of heat is required and where shade is often desirable, the arrangement serves an excellent purpose.

The Hot-bed.—The hot-bed consists of a box of dimensions like those described for a cold frame, which is placed above a mass of fermenting manure which supplies bottom heat. The old regulation style of hot-bed was made by digging out a pit the size of the frame, throwing out the soil to a depth of eighteen inches or two feet. Fill in the excavation with a foot depth of fresh horse manure mixed with straw as it comes from a stable where the animals are well bedded with straw. Tread the manure down firmly; put on the frame and cover the manure with eight to ten inches of good light and rich sandy loam that will not bake or crust over when sprinkled with water. Bank up the outside of the frame with the same kind of manure used inside, and cover with window sashes of the proper length to reach across the bed and rest on the sides. The sashes should not be too wide as it is desirable to uncover part of the bed at a time. As soon as the manure begins to ferment and heat the bed is ready for use. Sow seeds in rows from front to back of the bed, and germination will be very rapid. On warm days the cover should be lifted a little or partially or wholly removed, according to the heat of the day and the activity of the bottom heat in the bed. Water freely with water from which the chill has been removed.

This old style of hot-bed is contrived to freely employ the heat of the fermenting manure and to push plants during zero temperatures in the outer air. Of course, where winter temperatures but rarely fall to the freezing point, and where the winter day heat often runs at shirt sleeves and sun-bonnet degrees, such a hot-bed is as excessive in the garden as a feather-bed is in the house. For these reasons, the horse manure is made less active by considerable admixture of chaff or dried leaves or other mollients. This mixture is placed on the surface of the ground in a place protected from cold winds, and is properly mixed and packed down into a compact, flat pile, somewhat larger than the frame, which is placed upon the top of it and the same material is drawn up around the outside of the ends and sides of the frame. Inside the frame the soil is placed just as described for the hot-bed with a pit. This raised, instead of depressed, hot-bed is easier to make and it has other advantages for this climate. It is not likely to have its pit flooded and the heat choked off by rain water just at the time when its action is desired. It is also easier to prevent excessive heat because it allows better opportunities for radiation. But even with this the plants have to be very carefully watched and air freely given or they will become leggy and weak from too great forcing-heat. These local conditions have also given rise to other modifications of hot-bed arrangements which are excellent for this climate. One is shown in an adjacent engraving. By making the ends of the hot-bed with two pieces, the upper hinged to the lower, it is possible to open the ends easily either to avoid end-shade on the plants or to admit air and lower the temperature as may be desirable.



End-Opening for Hot Bed or Cold Frame.

A Horticultural Hot-box.—The late Ira W. Adams, of Potter valley, who has already been mentioned as a grower of great ingenuity and insight, devised a sort of automatic arrangement which changes from a hot-bed to a cold frame about the time the plants are ready to go from forcing to hardening off. He gives this description of it:

> I take a dry goods box, three or four feet long, two feet wide and two feet or more in depth. This is about as small as it should be; a much larger one can be used, if necessary. Into this I put fresh horse manure, and straw that has been used for bedding, and tramp it down occasionally as solid as possible, until it is within four inches from the top. Over this I scatter a little clean straw. I then use small boxes, three inches deep, and fill them nearly full with nicely prepared soil, and, after sowing my seed place each box on the warm bed and cover each one with a pane of glass, in order to retain moisture. It is necessary to remove the glass occasionally, for the purpose of admitting fresh air. The main bed will soon commence to heat, as well as the earth in the box. Great care must now be taken for a few days, otherwise the contents of the boxes might become too warm, which would cause the young plants to grow tall and spindling, thereby rendering them almost worthless. This can be easily obviated by lifting the boxes and placing them under an inch board, or a few bricks. On a cold night vary the boards or bricks as occasion may require. In a few days the plants will be up nicely, the heat of the bed will gradually grow less, and the plants will naturally favor themselves to the change. The arrangement will then become a "cold frame," and the plants will grow strong and stocky, providing care is taken to cover them during severe storms, as well as in cold days and nights. If the plants, while still small, commence to crowd each other too much, transplant them to an open, sheltered, raised bed where they can be cared for until ready to set out in permanent beds or rows.

A Warm Heap.—Another of Mr. Adams' arrangements to give his seed boxes just as little heat as suits the purpose consists in simply throwing up a heap of fresh horse manure, etc., under an old shed, and placing the seed-boxes on top of the heap. Great care must be taken for some days at least, as it becomes necessary to raise the boxes sometimes by placing them on a piece of board or bricks or to press them down a little into the heap, owing altogether to the amount of heat generated. A little too much is worse than not quite enough. After the plants get a few inches high they can be transplanted into open beds somewhat sheltered from the north winds, where they can remain until conditions favor their planting out.

Watering.—In growing plants with heat, moisture conditions must be especially regarded. Too great moisture and "damping off" of seedlings is largely prevented in common vegetable seedlings by adequate ventilation which has already been emphasized in connection with prevention of excessive heat. Too little moisture is almost as dangerous as too much. There should be, then, ample watering with a fine spray or sprinkle of water from which the chill has been removed. Most of the time, water standing in the sun for a day will be of satisfactory warmth, but if not, a little boiling water from the kitchen will temper quite a volume of cold water for use in the beds and frames.

Damping Off.—Damping off of seedlings is due to a fungus which attacks the tender growth when there is too much surface moisture. It may be produced by rather a small amount of water, provided the soil is heavy and the water is not rapidly absorbed and distributed. On the other hand, a lighter soil taking water more easily may grow plants without damping off, even though a great deal more water has been used than on the heavier soil. Too much shade which prevents the sun from drying the surface soil is also likely to produce damping off, therefore one has to provide for just the right amount of shade and the right amount of ventilation through circulation of the air, etc. The use of sand on the surface of a heavier soil may save plants from damping off, because the sand passes the water quickly and dries, while a heavier surface soil would remain soggy. Surface drying may also be promoted by sprinkling in the morning rather than in the afternoon or evening. Lime may be of advantage if not used in too great quantities because it disintegrates the surface of the soil and helps to produce a dryness which is desirable. Success in keeping the surface dry enough and yet providing the seedlings with moisture for a free and satisfactory growth is a matter which must be determined by experience and good judgment and cannot be completely covered by any formula or prescription. Damping off may be reduced or prevented by sterilization of the soil before planting by using a pan-like cover of the surface and admitting live steam under the cover and raising the surface to a high heat—but this is a process too elaborate for small growers to undertake.

Covering for Beds and Frames.—California growers largely substitute cloth for glass in covering hot-beds or cold frames, because it gives all the protection needed, is also rather more of a safeguard against overheating and it furnishes shade from too intense sun heat which is liable to come on any winter day and do harm. This is an especially valuable feature in amateur growing where one's attention is apt to be distracted by other affairs. Besides, the cloth is of nominal cost. In the drier parts of the state the cloth is used without preparation. Where rains are more frequent water-proofing is desirable. Take white cloth of a close texture, stretch it, and nail it on frames of any size you wish, putting in cross-bars to sustain the cloth if the frame is large. Mix two ounces of lime water, four ounces of linseed oil, one ounce of white of eggs separately, two ounces of yolk of eggs; mix the lime and oil with a very gentle heat; heat the eggs separately and mix with the former. Spread the mixture with a paint-brush on the cloth, allowing each coat to dry before applying another, until they become waterproof.

To make waterproof cloth with less labor if considerable quantity is wanted: Soften four and one-half ounces of glue in eight and three-quarter pints of water, cold at first; then dissolve in, say a wash-boiler full (six gallons) of warm water, with two and one-half ounces of hard soap; put in the cloth and boil for an hour, wring and dry; then prepare a bath of a pound of alum and a pound of salt to about five gallons of water, soak the prepared cloth in it for a couple of hours, rinse with clear water and dry. One gallon of the glue salution will soak about ten yards of cloth. This cloth has been used in southern California for several years without mildewing and it will hold water by the pailful.

Handling of Seedlings.—As has been hinted already, seedlings grown by artificial heat or protection should be brought along by such adjustment of heat, moisture and fresh air that they are of good healthy color and sturdy growth. It is common practice to transplant the seedlings when quite small to other boxes of rather rich soil, in which they are more widely spaced, and to continue the growth with the heat for a time and then move the box to a cold frame, giving them progressively more air and less protection until they acquire a hardiness for the open air. In the farm garden these every-day coddling arts of the plantsman are apt to be neglected and it will answer very well to thin out the plants enough in the original seed-boxes and to harden them by gradually increasing the exposure in the declining heat of the hot-bed, and then under slight shelter in the open air, until the time comes for their removal to open ground. If, however, there is likely to be some time before planting out, the transplanting from the seed-box to a protected bed in the open air will allow the postponement of transplanting to garden or field until a considerably later date. It is a mistake to hold too long in the hot-bed or frame with the idea of gaining time by having large plants to transplant. Good, sturdy plants, well used to fresh air and the lower temperatures, will make the best records in the open.

Growing Plants in Separate Containers.—Planting out small seedlings in separate receptacles like berry baskets, paper flower pots, etc., will secure strong development of single plants, if these containers can be handled in a way to prevent too free circulation of air around them and too great drying out. If this is not done, the plants in the seed-beds or seed-boxes will show greater thrift, To secure better moisture and at the same time great facility in planting out, this method is commended.

> Take common printer's cardboard and have it cut into strips 4x22 inches. By folding these tightly around a block of wood 3 by 3 inches wide and 4 inches high, slipping off and putting in a pin, we have a square pot with no bottom. These are pressed flat and packed a thousand in a bunch for convenience, until wanted. When ready to use, open, give a quick pinch on the corners not folded, and the box will stand almost perfectly square. These fit nicely together and can be opened, shaped and set rapidly. Place several rows at a time, drop a little well-rotted manure in each one, press down, then fill in the soil with a shovel, set a plant in each box, then fill in more soil until the boxes cannot be seen. This prevents the air from getting in and drying too rapidly. When ready for the field slip a trowel under and place them on a sled to haul out to the field. The manure serves every purpose of a paper bottom in preventing soil and plant from dropping out, and it does not interfere with the moisture either going down or coming up. It is not so necessary to remove these boxes when planting out, and if we do wish to take them off they are much more easily removed than those with bottoms.

Planting Seedlings.—The points to observe for planting out seedlings in the open air are almost exactly the same as those already given in this chapter for the arrangement of proper moisture conditions for seed germination. Depth of planting depends upon the same conditions; firming of the soil about the rootlets is for the same reasons; a loose surface above and frequent cultivation afterward are essential because of considerations already described. The judicious use of water at transplanting, by pouring it in the hole or running it along in the drill or furrow, is a very important point in late work or in planting out when the season is rather dry, but the use of water must always be followed, when the soil has dried somewhat, by stirring of the surface or other means of preventing evaporation or else the plants will dwindle and on investigation the dead stem will be found to resemble a match stuck in on unburned brick, if the soil is at all heavy in its nature.

Seedlings to be planted in the field for horse cultivation are distanced by the use of a marker, as described in the chapter on laying off. In small garden beds for hand work, the plants can be very accurately distanced both ways by using a "planting board." It is made of a width equal to the desired distance between the rows and of a length equal to the width of the bed, and is carefully cut, by the use of a carpenter's square, so that the ends are exactly at right angles to the sides. By stretching a line along the length of the bed, and making one end of the board true with that line, the sides of the board will mark two parallel lines across the bed and notches cut at desired distances in the sides of the board will show where the plants are to be set. If the board is carefully used the bed may be quickly set with plants which will stand in straight lines both ways. Standing on the board while planting prevents impacting the ground surface and disfiguring it with footprints.

Plants Ready Grown in Hills for Transplanting.—All seedlings which it is desirable to grow in groups or hills are very neatly and safely handled by the use of inverted sods in connection with the hot-box already described. This can be done with sods of native growth six inches square and four inches deep or alfalfa can be grown in seed boxes on which sods will form sufficiently in six weeks from sowing the seed. Make a temporary floor of old boards on top of the packed manure of the hot-box. The inverted sods are then packed closely on this floor with the grass gathered in nicely under each sod. Exactly in the middle of each inverted sod thrust a small stick, and after scarifying each sod thoroughly an inch or two in depth with an old caseknife, carefully put over the whole bed two inches of rich compost, made of fine creek sand, and decayed sods, a year or two old, mixed with fine sweepings from the cow-yard gathered in summer and protected from winter rains. Tamp this prepared soil pretty firmly with the back of a hoe, and plant the seeds an inch or so in depth around each stick which serves to indicate the middle of each sod. Plant six to eight seeds in a hill, leaving finally three of the strongest plants. A box three by two feet will hold twenty-four sods, which may be planted for two hills of cucumbers, six of muskmelons, six of watermelons, and ten hills of pole beans, or eight hills of beans and two hills of summer squashes, and these will furnish a family of five all it can use if the plants are well taken care of. The box for early plants should be placed on the south side of a shed or barn in order to protect it from strong north winds, heavy cold rains, as well as danger of frosts, and should be watered as needed with lukewarm water Transplant the sods when safe by running a wide shingle or spade on the floor under each sod. In planting out the sods must be well bedded in moist soil which is closely firmed around them and the surface kept loose.

Open Air Seed-Beds.—But though the amateur should know all these ways of growing seedlings for transplanting by such devices as have been described, he should be assured that very much can be done by growing séedlings in the open air and open ground without artificial heat or protection. Seed beds are made for this purpose exactly as they are for growing vegetables without transplanting, as described in Chapter V—using the "raised bed" or the "depressed bed," etc., according to the expectation of more or less moisture following the seed sowing, and all the suggestions for open air seed starting given earlier in this chapter are also applicable. Of course, also, many plants removed in thinning the standing rows can be used in transplanting for additional areas of the same kinds. The amateur should quickly make himself competent in the art of transplanting.

Cuttings and Layers.—Many herbaceous stems of garden vegetables root readily from cuttings. Higher heat and greater moisture are as a rule requisite for such cuttings than for hardwood cuttings of fruiting and flowering plants, but some, like the potato, sweet potato, globe artichocke, etc., root quickly in open ground taken from sprouts taken from the parent stock, and others, like the tomato, grow from cuttings of aerial stems. In the open ground the soil must be warm and moist and the air moist also. These conditions usually occur in California at the beginning or especially toward the end of the rainy season, or they can be produced in a hot-bed at any time. The cuttings should not wilt, and shade is of advantage when practicable, for cuttings made from aerial stems, as they are more prone to collapse than sprouts from the tuber or root crown.

Layering is often a handy way to multiply many vegetables with branching stems. Cover the stems with moist earth and they usually root readily. In some cases a short slit with a knife lengthwise of buried stem aids in rooting.

A Consideration of Cans.—It would not do to ignore the can method of vegetable growing and deny this refuse tinware its place in amateur gardening, for really some very creditable things are done in cans. If one prepares the right kind of soil, with such texture that it will form neither a leach nor a brick, and then strives for correct temperature and moisture conditions and makes drainage holes enough, a plant will grow in a tin can as well as in some more distinguished receptacle. Many housewives grow very creditable tender plants for planting out by using old cans and a sunny window shelf. Some devoted city gardeners make surprising successes on the old can foundation. In San Jose a few years ago there was a back yard twelve by twenty-five feet surrounded by high whitewashed fences and sheds which cast a blinding glare in the eye of the visitor. Gardening enthusiasm and tin cans transformed the scene. Tomato vines ran above the eaves of the shed, being trained to the wall like grapevines. Between the tomato plants were squash vines from which the laterals and leaves were cut as they grew toward the roof, so that they were little more than a bare stem below the eaves, but had a most luxurious growth at the eaves and on the roof of the shed and back porch and along top of fences. Large squashes ripened on the roof and shelves at the eaves and fence tops. Lima beans ran in various directions. String beans, peppers, and mint grew below the running vines. Tomato plants over six feet in height were severely pruned near the ground to a bare stalk, giving free circulation to cats, breezes, and a little direct but more reflected sunshine. Cans of all sizes were used; old rusty five-gallon cans with the bottoms punched full of holes; small cans, one set over another and filled half full of fresh bones, and over these several inches of fresh wood ashes. Water poured into the cans, leached through the ashes, combining a complete fertilizer and system of sub-irrigation. The cans were often artfully concealed from sight, but they were there as the foundation of an enterprise. By their use and the employment of vertical space for the plant extension, this little mite of a city back yard was made into a pretty greenery without interfering with its function as a clothes-drying yard on Mondays. When one sees such things he is led to wonder whether there is anything which Will and Work and Water cannot accomplish.

CHAPTER XII.

ARTICHOKES.

THE GLOBE OR BUR ARTICHOKE.—*Cynara Scolymus.*

French, artichant; German, artischoke; Dutch, artisjok; Danish, artiskok; Italian, articiocca, carciofo; Spanish, alcachofa; Portuguese, alcachofra.

Edible part, portions of young flower buds.

THE CARDOON.—*Cynara cardunculus.*

French, cardon; German, kardon; Flemish, kardoen; Italian, Spanish and Portuguese, cardo.

THE JERUSALEM ARTICHOKE.—*Helianthus tuberosus.*

French, topinambour; German, erdapfel; Flemish, aardpeer; Danish, jordskokken; Italian, girasole del canada; Spanish, namara; Portuguese topinambor.

Edible part, the tuber.

San Francisco has the reputation of being the city of the United States best supplied with the delicious young flower buds of the globe artichoke. Although this is true, it is also a fact that the plant is not used to even a small fraction of its possibility in California. It is perfectly hardy in our valley climates, in fact it is induced to make its chief growth in the winter and yields its crop from November onward, thus completely reversing its eastern and north European record, where it starts growth in the spring from roots which have been covered out of reach of freezing all winter. The plant is, therefore, of especial value in California for use in late winter and early spring when garden supplies are scantiest. It is a garden ornament also with its height of four feet or more, its large pinnatifid leaves, light green above and whitish below, and its flowers in the style of a colossal thistle head.

Although grown in home and market gardens in most of our valley and foothill regions the globe artichoke as a shipping vegetable has received considerable attention during recent years, and the chief producing region is on the coast side of San Mateo county, just south of San Francisco.* Shipments to eastern cities begin in December or January, and continue until June. Such shipments reached about 300 carloads in 1913, and averages annually about that amount. The buds are packed in standard size apple boxes and are made to lie on their sides in the boxes. Such a box holds about six dozen large buds or about fifteen dozen small ones, and about five hundred boxes fill a car, for which the growers expect to get about $600. It is fair to expect an increasing demand because the vegetable is only beginning to be understood and appreciated by Americans. When they learn its delicacy a continuous supply of fresh artichokes from California during the winter season can be profitably sold. The canning of artichokes is also being largely undertaken.

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*A detailed account of this industry by Paul Parker is given in the Pacific Rural Press of February 13, 1915.

Soil.—The globe artichoke will thrive on any well-prepared garden soil and does not refuse a pretty heavy adobe if well cultivated to retain moisture. The chief commercial crop is made on the sandy loams of the ocean slopes, where fogs moisten the air of the dry season and the ocean moderates the temperature in winter, which is the cropping season. But on such soils water and fertilizers must be freely used. The plant delights in manuring and is benefited by it both in the tenderness of its buds and the multiplication of bearing stems. Either a complete commercial fertilizer or barnyard manure may be quite freely used—the latter even at the rate of ten or twelve tons to the acre, applied early in the rainy season.

Propagation.—The plant grows readily from seed which may be planted either in boxes or the open ground in September, if irrigation is available; if not, sow as soon as the ground is deeply moistened by rain. The seedlings may be transplanted, when six or eight inches high, to permanent place whenever the ground is suitable the same season. Transplanted seedlings usually bear within a year. Care should be taken not to cover the crown deeply in transplanting.

But there is much variation in plants grown from seed and those grown from parts of old plants of good type are almost exclusively used in commercial practice. The plant grows readily from dividing the stool or from suckers detached from the root crown. The latter furnish an excellent means of multiplication and should be secured by first uncovering the stool as soon as there is a good growth of new shoots with well-developed leaves. Remove the shoots carefully with a knife or sharp gouge so as to take a small part of the parent root at the base of the shoot. Many plants can thus be taken from a single root-crown and a few of the best shoots left for growth. Shorten the leaves somewhat to reduce evaporation until new roots are formed. These sprouts, which should be taken off during the rainy season, can be planted at once in permanent place if the ground is warm and moist and will bear late in the same year, if their growth is promoted by frequent watering. But plants do not reach maximum production of three or four dozen buds to the stool until the third year. Although the plants can be kept for nine or ten years in service, better product can be had by renewing at the end of the fifth year, using the suckers from the old plants for a new start.

Distance.—So free is the growth in this state, it is desirable to give a good distance. In the garden four feet apart in rows which are five or six feet apart is often practiced. But as the plant is high and rather dense, it is better to place the rows in the background of the small garden and its use as an ornamental hedge or screen is suggested, providing the ground is kept rich and well cultivated. A row of the plants along an irrigating ditch is usually very desirable, both for use and beauty.

In commercial planting on the seashore slopes and flats it has been desirable to give the plants very wide distances. Speaking of the practice in San Mateo county, Mr. Parker says:

> About 900 plants are figured to the acre. On level ground they are set six feet apart with ten feet spaces between rows. This gives ample space for wagons, cultivators, and small irrigation ditches. On many of the farms they raise peas, corn, beans, and tomatoes between the rows. Where ground is high and the irrigation ditches have to be deep, the artichokes are planted on each side of the ditch so that there is sometimes fully thirty feet space between the canals.

Gathering.—The flower buds should be removed as soon as they are well formed and before the scales open. In this condition they are more tender and a larger portion of the scale is edible. As the bud stands at the apex of the shoot, the shoot should be cut to the ground. If this is done the plant is induced to send up more shoots. As soon as the flowers are allowed to open, the growth of shoots from below is checked or stopped. Hence prompt cutting as soon as in condition insures a larger bearing season, but as other vegetables come into condition, the plants should be allowed to make free top growth for the reinforcement of the roots for the next season.

Of the way a commercial plantation can be made to deliver its product in the winter when demand is best, Mr. Parker says:

> The plants are cut down to the ground during June and July. The new shoots will not bear until September or October, the top buds first; and cutting these off causes new buds continually to be sent out. This continues during the winter, reaching the maximum yield in January. In the following May no more buds are cut off, but are allowed to bloom. The later the cutting down of the plant, the larger the buds will be the next winter. When the plants are cut back too early in June, the buds will appear very early but they are always small.

Variety.—The variety chiefly grown in California is the Large Green Paris, a vigorous grower yielding buds of large size with scales very fleshy at the base and set in a broad receptacle also fleshy. This variety grown for succession seems to leave little opportunity for the use of other varieties.

It is very necessary that discrimination should be made against poor plants which have loose bud-formation and a spiny growth. They should be extirpated.

THE CARDOON.

The cardoon is closely related to the globe artichoke, and resembles it in growth except that it attains larger size. Its edible part is, however, the stem and midrib of the leaf, and not the flower bud as in the artichoke. It is propagated from seed and not from sprouts, and to produce satisfactory quality, the seedling must be pushed to quick growth by ample manure and moisture. The cardoon is hardy in the coast region, and can be grown for autumn or spring use, or for succession at nearly all times. The plant is ready for use in about six months from sowing. It is apt to become a bad weed in pasture, field or roadsides.

THE JERUSALEM ARTICHOKE.

This plant which will be readily recognized as a tuberous-rooted sunflower, is exceedingly prolific in California. It is not largely used for human food, though it is usually to be found in the San Francisco market. It somewhat resembles a potato in flavor, and yet has its own distinctive character, and is cooked in several ways. It may be baked, or pared or cooked like salsify, or boiled for use in soups and salads. It does not resemble the potato in keeping quality, for it is apt to decay quickly after digging. It must, therefore, be freshly dug from the ground and not stored.

Soil, Culture and Yield.—The Jerusalem artichoke is not very particular about soil. It reaches better form in rather a light soil, as does a potato, and it yields enormously on a rich loam, but it will probably yield a greater weight on a poor, dry soil than any other crop known. S. J. Murdock, of Orange county, gives this account of the plant:

> The preparation of the ground and the subsequent cultivation is the same as for potatoes; the rows should not be less than four feet apart, and three feet between plants. Plant small tubers or the larger ones cut to two eyes, and about four inches deep. Keep the ground stirred to prevent weeds, till the plants shade the patch, and then they will take care of themselves. They should yield from seven to fifteen tons per acre, or even more, with a good stand, good soil, and care. Last year was a dry one, and a neighbor of mine planted one acre to artichokes, but got but little over half a stand on account of parts of his land being too dry. Yet with his partial stand he raised ten tons of tubers.

But Mr. Murdock and his neighbors operate on a peat soil of great looseness and richness, which favors the maximum size and multiplication of the tubers. His results are, therefore, not attainable everywhere, but still the growth and productiveness of the plant is marvelous in this climate.

Gathering.—In the garden the artichoke bed can be regarded as a permanent investment. Digging can begin in the autumn at one end of the bed and proceed regularly through it as the tubers are wanted until growth starts in the spring. Selecting the large tubers for use and leaving the small ones in the soil will harvest and replant the crop at one operation. Before the rains are over, the bed should have a top dressing of manure and then it is ready for another season, with no further care except pulling weeds which start early.

The Jerusalem artichoke has been commended for years as a food for hogs—the animals to do their own harvesting. Some growers are very enthusiastic over it, but why it has not been more widely employed has never been fully explained. Some growers commend them highly as cow-feed, and when boiled, fowls eat them readily, but the cost of digging for such purposes is a serious drawback.

Varieties.—Two varieties have been widely distributed in California: the White French and the Red Brazilian. The white kind is preferred for table use and the red is chosen for field growth for stock, as it is rather more vigorous and prolific. The red variety is, however, frequently found in our vegetable markets and is acceptable for table use.

CHAPTER XIII.

ASPARAGUS.

ASPARAGUS—*Asparagus Officinalis.*

French, asperge; German, spargel; Flemish and Dutch, aspersie; Danish asparges; Italian, sparagio; Spanish, esparrago; Portuguese, espargo.

Asparagus is a leading winter vegetable in California and is produced as a field crop for local sale, for canning, and for eastern shipment. It is not grown, however, as a garden crop for home use as widely as it should be. This is probably due in part to the fact that in nearly all towns it can be cheaply bought during the winter and spring; in part, also, to an exaggerated notion of the difficulty of making and caring for an asparagus bed. In almost all parts of the state it is not difficult for the attentive gardener to secure crop and quality which will amply repay his efforts, but one has to know the nature and needs of the plant and meet them.

Regions open to coast influences either directly or through gaps in the Coast Range, or regions where atmospheric humidity is increased somewhat by evaporation from moist soils or wide water surface, as in the case in interior river bottoms, have superior conditions for the growth of the plant which is maritime in its origin and nature. On the peat lands near the ocean in Orange county asparagus established itself as an escape from cultivation and it is stated that this demonstration of its choice of situation suggested the plantings for distant shipment which some years ago were of considerable commercial importance, but recently the crop has been carried to much greater attainment in other parts of the state.

Soil.—Asparagus is chiefly grown commercially on peat lands in the deltas of rivers and on soft, deep loams elsewhere with large use of animal manures. These peat lands are composed of vegetable debris intermixed with sand, and are very loose and penetrable in their texture. They are also underlaid by impervious strata at considerable depth, which holds water within reach of the plant roots. Such conditions are found in the reclaimed lands of the Sacramento and San Joaquin deltas, where the largest growing areas and canning factories are located. But it is not essential that just these conditions prevail. In the Santa Clara valley and elsewhere in central California deep alluvial soils without any great amount of vegetable debris, for many years furnished large quantities to the markets. More recently a commercial product for very early shipment has been developed in the Imperial valley adjacent to the Colorado river in the extreme southeast corner of the state.

Any deep, rich sandy loam, moist enough to give a winter and spring crop and a summer growth of foliage to reinforce the roots and endure the California valley frosts, of which the plant is very tolerant, will grow good crops of asparagus for years with proper cultivation, generous manuring, and occasional salting. Soils which are too wet or too dry or too heavy to allow free growth, yield inferior shoots, tough, stringy, or bitter as the case may be. Of course a heavy soil may be improved for a garden bed of asparagus by free use of sand and manure well worked through it but commercial plantings should only be made on naturally fit soils.

The Annual Product.—The asparagus product is upwards of 1500 carloads a year of which San Joaquin and Contra Costa counties produce 900; Sacramento county 300; San Francisco bay region 200, and Imperial valley 100. Asparagus is the second in importance of California canned vegetables—second only to tomatoes, as shown in Chapter I. About one-third of the product is canned, one-third locally consumed as a fresh vegetable, and one-third shipped fresh to eastern points.*

Growing the Plants.—Asparagus grows readily from seed and in this state well-grown yearling roots are used for planting out in preference to older ones. The house gardener can, therefore, save a year's time by buying roots from the seedsmen, but for the large plantation the grower will usually grow his own plants. This can be done in the open air; adequate moisture and a light, fine soil will insure success the first year if the seed is grown early enough to get the benefit of a full season's growth. A light, coarse soil which may be excellent for the after growth of the roots, is not so good for starting the seedlings because of danger of surface drying. A mixture of fine sediment will improve a coarse soil for this purpose. A very good way to get quick germination and large root growth is to start the seed bed in February or March, as the soil becomes warm: get good, fresh seed; take boxes, say apple boxes, or any boxes of about that size; get good, clean sand, and mix sand and seed together, about fifteen parts of sand to one part of seed; fill the boxes with sand and seed mixed as described; set away in a warm place and pour on water, quite warm, two or three times during the first two days.

In the meantime, prepare and richly pulverize a piece of ground for a seed-bed. Make rows about four feet apart by raking all lumps and clods away, forming a kind of ditch say two or three inches below the level of the land. Make your ditches about one foot wide, and watch the seed closely, for if the seed is good in about seven days nearly all the seeds will begin to sprout. Then take the boxes of sand and seed to the prepared ground and sprinkle it in the rows or ditches quite freely, using judgment all the time not to get too much or too little. Cover up with finely pulverized earth about one and one-half inches deep, and if the ground is moist your plants will be up and growing in a very few days, at least before the weeds will make their appearance. Let the plants stand there; but take good care of them. They are very quickly injured by drying out. The bed should be kept clean and moist.

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*The fullest account of the commercial aspects of California asparagus growing is given in Bulletin 1 of the State Market Commission, San Francisco, 1916.

This method gives seedlings scattered through a space one foot wide and though the cultivator may be used between these foot-strips, there must be hand-pulling of weeds within the strips. For this reason some growers prefer to start the plants in thin rows by sowing the seed in a drill and afterwards spacing the plants in the row to prevent crowding on the roots. In this practice the rows are placed one to two feet apart according as hand or horse cultivation is to be practiced. Whichever method is followed it is important to start the seeds in a slight depression so that subsequent cultivation may level the ground and bring a deeper covering over the young root crowns to guard them from excessive heat. The seed can, however, in a light soil, be placed at a depth of two inches and the moisture can be retained near the surface by careful raking to prevent crusting over. A rake with thin teeth can be used even after the seedlings have appeared, to keep the soil loose about them.

Planting Out the Garden Bed.—Garden beds or rows can be made by the old system of trenching if it is desired, although recent practice rather discards it. Trench about eighteen or twenty inches deep, then fill up with well-rotted manure, dig the next trench and throw the dirt over on top of the trench filled with manure, and so on until all is trenched. Then begin and stir the last trench up with the dirt, measure off the distance the asparagus plants are to stand, say two feet if for hand hoeing, and then stick a stake, set the plants, and then take the dirt off of the next trench to cover the plants, and so on until over the ground, when all the plants will be set.

If the garden is small, the soil rich, the moisture ample, some other use can be made of the bed the first year. The stakes will show the locations of the asparagus roots. Between these stakes set a cabbage plant and then in the middle of the row set out lettuce plants, and sow radishes, carrots, and early turnips. The carrots and radishes will be disposed of before the cabbages are ready and some other quick-growing vegetable can be put in, after irrigation. The second year give the whole ground to the asparagus, and in the fall clean off the bed, cover with a coat of coarse manure to keep the ground from packing with the heavy rains, and fork it all in early in the following spring, being careful not to injure the root crowns. A small cutting can be made the second season, but it will help future crops to cut very little.

Field Planting of Asparagus.—Roots can be moved from the seed-bed to the field at any time from November to April, according to condition of soil and activity of roots. As with other plantings, however, early practice is better when all is favorable. As to methods of planting in the field the experience of two prominent large-scale growers is given. First, the method of Mr. William Boots, one of the old line asparagus growers on the alluvial lands of the Santa Clara valley:

> Next March (for I think March the best month to plant in, all else being equal) choose a good piece of land, the very best is none too good, and plow just as deep as you can. I plow with four good horses on a single plow, and plow one foot deep, getting the land in as good condition as possible. Take a good team and draw furrows where the rows are wanted, going twice in the same place, just as deep as we can get the plow to run, throwing the furrow each way, making the distance six feet between rows. Then carefully take up the plants, carefully separate them, for if they have been very closely grown they will cling together; spread out the roots as you plant them, clearing away all clods or anything that may hinder the growth. Plant not closer than three feet between plants in the rows. For field planting for the market by all means do not plant closer than six feet between the rows, and three feet apart in the rows; for if there is a plant that delights in plenty of room and air it certainly is asparagus. Cover the plants about two inches deep, and during the summer cultivation the pulverized earth will drop into the ditches, and by the time the season's cultivation is over the ditches or furrows will be nearly full, which finishes the first year in the field.

Another method is that approved by S. J. Murdock, on the peat lands of Orange county:

> The rows should be four feet apart and the plants eighteen inches from each other in the rows, and even more room would be better if the land is not too valuable. After the ground is well plowed and finely harrowed, mark out the rows the desired distance apart with a plow by going twice in each row, throwing a furrow each way from the center of the row, and from eight to twelve inches deep; then go one or more rounds in this with a cultivator, closed up, so as to loosen up the soil well in the bottom of the row. If you have any fine fertilizer put it in the row where you want to set your plants; mix well with the soil and set your plants over it. Place the plants in the bottom of the prepared furrow, spread out the roots and cover crown and all about two or three inches—the lighter the soil the deeper the plants should be placed—so as to secure the proper moisture till they begin to strike root. After the planting has been done, take a light steel garden rake, or, if the rows are even enough, we would prefer the wheel hoe with the rakes on, and stir the soil the whole length of the rows. Then, when the shoots begin to grow and show themselves three or four inches high, the soil should be gradually hoed or cultivated to the plants till the surface is level. The ground should be kept moist, and in most localities irrigation will be found necessary to secure the best results. Do not neglect thorough cultivation, but after the roots begin to fill the ground do not work too deep, as there is danger of injuring them.

Giving the plant plenty of room favors its productive longevity, while closer planting may secure larger acre-yield at first. In the large commercial plantations on reclaimed lands of the Sacramento and San Joaquin river bottoms the plants are usually given much greater distances—say nine or ten feet between the rows and the plants two feet apart in the row. Much greater depth of covering is secured by ridging the light, peaty soil, so that the shoots have to pierce about a foot of covering on their way to the light. This

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Field of banked celery in the vegetable region of Orange County.—Page 182.

Corn field near a head ditch in Princeton District of Colusa County.—Page 187.

secures the great length of large white shoots which are characteristic of California canned asparagus. The ridges are made by the use of plows, disks and crowders which cut deeply between the rows and shift the soil over the root crowns. These ridges are split with a plow or disk when the cutting season is over, and the land leveled for the summer growth. This is simply an enlargement of old practices, as described below, as the light soil, largely made of partly decomposed vegetation, favors cheap shifting of great bulks of it to serve different needs of plants.

Later Treatment of the Asparagus Field.—There are several points to gain in subsequent cultivation of the asparagus field. One is early starting of the plants, and for that purpose some growers plow first away from the rows to open the ground better to the winter sunshine; another is to induce the growth of long, tender, white shoots, and to retain moisture for prolonging the cutting season, and to aid summer growth of foliage, and for these ends the early spring plowing is to cover the rows with a deep layer of loose soil. Mr. Boots' method is as follows:

> Now do not attempt to cut any asparagus until your plants have grown two years, but cultivate thoroughly. The second season's growth you will find quite strong, and along in the fall, after the frost has killed the tops, take a mowing machine or scythe and cut the tops close to the ground, pile up and burn on the ground, as your plants are too deep in the ground to be affected by the fire. Some time in November or December and not later than the first of January, take two horses and plow, and go along the rows close to the stubs that you cut off, throwing the furrows from the rows, then follow along with sharp hoes and cut the stubs way low down; also break down the little ridge that will be left between the furrows. The sun and air will warm and start the roots to growing, sometimes as early as the first of January, and the first plowing ought to be done before the sprouts begin to make their appearance.
>
> Along in the early spring after the heavy rains are over, and the plants have begun to push up nice healthy sprouts, take two horses and plow, and reverse the operation by throwing the earth back onto the rows, leaving the dead furrow in the center between the rows, covering the plants up deeply, leaving the plants under the ridge. Then take a fine, sharp-toothed harrow, and drag along the rows the same way the plow went, which will cut up and drag out all clods and lumps, and leave the earth in fine condition for the sprouts to come up through, for should the ground not be in good order, your "grass" will be crippled and crooked. It will also be tough, fibrous and bitter.
>
> Continue thorough cultivation with plenty of manure, no matter what kind or how rough. At the same time finely rotted manure is profitable. There is one thing to be borne in mind in the producing of asparagus; you can't fertilize too much. The better cultivated and the more fertilizers the greater will be the quantity and the better will be the quality produced. We plow thoroughly about three times a year, and harrow as often, and in the cutting season keep the weeds out with hoes.

The method of alternately opening and covering the rows is somewhat conditioned upon the local soil and rainfall. The looser the soil and the lighter the winter rain, the less need of such operation, because in such situations the heat readily penetrates and the roots answer quickly without uncovering, which may too greatly facilitate evaporation and thus be dangerous in dry localities, even in the rainy season. Where these conditions prevail thorough cleaning, plowing, and manuring will fit the field for the winter. Mr. Murdock gives this advice:

> In the fall or early winter, when the tops have turned brown, the ground should be cleaned and all rubbish burned, for if delayed the seed will drop and get scattered, which will come up and may prove eventually to be the worst weed the grower will have to contend with, for if allowed to grow after once started it will soon fill the whole ground with a mass of roots, and very soon spoil the whole patch. As soon as the ground is cleaned the whole field should be well cultivated, and coarse manure spread over the entire surface, so that the rains can dissolve and carry down the soluble plant food to the roots. As the period of rest here in our mild and warm winters is very short, with this strong and persisting plant no delay should be indulged in furnishing the necessary plant food.

Quite free use of common salt is desirable for asparagus providing the land is not naturally saline as is the case in some regions where it is largely grown. Cheap, refuse salt answers well, and in garden practice the use of any old brine from the pickle or pork barrel. An application of five to ten tons of stable manure or one ton of a complete commercial fertilizer per acre can be frequently used. One grower in the Imperial valley has used twenty tons of cow manure per acre annually for five years. On the best peat lands the crop is grown for several years without fertilization.

The surface application of all manures at the beginning of the rainy season seems best to suit California conditions.

Harvesting.—Growers agree in advising very little, if any, cutting the second year in the field. The third season should be very productive if the plants have been generously treated, and thence onward independently, if the strength of the soil can be kept up, although canners are apt to refuse the product of plantings over nine years old as likely to be tough and bitter. Still older fields do yield good stuff in some cases. An average product is about two tons of marketable shoots to the acre, while three and even four tons are occasionally secured. Much evidently depends on the land and the care of the plantation.

Mr. Murdock's suggestions on policies in cutting are as follows:

> Cut all the shoots clean at each cutting during the season, whether they are large enough to use or not, for if part of stalks are allowed to grow they will prevent other buds from throwing up stalks, and make the season's cutting short. Keep the ground well cleaned during the harvesting period, and if you have been liberal with your fertilizers and have kept your ground moist, your crop will last as long as a profitable demand is likely to exist. Yet, beware of prolonging the harvesting period too late, so as to weaken the next year's crop, as the nature of the crop requires that, to reproduce annually its crop of shoots, something must be left to grow so as to foster the formation of new roots and a new set of buds. If your season commences early you should lay by the knife later on to correspond; then let all the tops grow and do not cull out the large shoots afterward. The time that should elapse be-

tween cuttings varies in different soils, some being warmer and consequently quicker than others; then again, much depends on the weather; some years we will have warm days in February, which will necessitate cutting twice each week, and it may be followed by cold days in March, when the cuttings will be meager once a week; and again in the warm days of May it may require three cuttings per week to prevent the tips from bursting, which spoils it for market.

Some cut with a long-handled gouge which does less injury to roots by side-cutting, others use a long butcher knife. One form of cutter is a tube about fifteen inches long, with a handle fitted in one end and the other end opened and flattened into cutting edge, which is broad, sharp and forked.

There is variation in the demand for color in the product. The local demand runs largely for a green tinge; the canning demand is for white, and the eastern shipping demand is largely for green. To produce good, tender, white asparagus it is necessary to cover more deeply and blanch the shoots by continued growth through a thicker layer of loose earth. It is also necessary to cut as soon as the tip is seen, which requires daily cutting in the height of the season. The knife is plunged into the loose ridge through which the shoot is rising so as to sever it about six or eight inches below the surface where the tip appears.

Comparatively little asparagus is bunched in California, except for fresh shipment to eastern markets; the bulk of it being marketed in large boxes as loose stalks which are both wholesaled and retailed by the pound. For distance shipments the boxes are marked so that the stems stand on their ends just as they grow, for they are apt to bend out of shape if lying on the sides. When the asparagus is brought into the packing house for shipping fresh it is first separated into different grades. A tray of a size is then carried by a worker to a bench where the asparagus is laid stalk by stalk in a circular press and tied into a bunch with cotton tape or raffia. All the bunches are of one size and there is but one grade in each bunch. After being passed to an inspector, who returns any that is not up to the standard, the bunches have their ends cut off and are then wrapped in oiled paper and packed in crates. A couple of inches of wet moss is placed in the bottom of each crate to keep the asparagus fresh, and an inch or two of space is left at the top, as the stalks continue to grow during their journey and that amount of head-room is desirable.

For near marketing in the height of the season the asparagus is usually delivered in open boxes holding forty to fifty pounds. Where bunching is desirable in garden practice, it can be neatly done by putting the stalks point downwards in a teacup, tying the bunch, and then squaring off the butts with a sharp knife.

The asparagus season in California extends from January until June; although later cutting is sometimes practiced, it is not, as stated, for the good of the plants.

The Asparagus Rust.—The disease made a vigorous attack upon California asparagus fields in 1905. A careful study of the disease and experimentation conducted by Prof. R. E. Smith demonstrated that the trouble can be controlled by proper use of sulphur for the protection of the top growth after the cutting season. Since that time, rust has not been considered a menace. Full information can be had from the University Experiment Station at Berkeley.

VARIETIES CHIEFLY GROWN IN CALIFORNIA.

Conover's Colossal: an old standard variety; large tender stalks of good flavor. Largely grown for the canneries, which use it almost to the exclusion of other sorts.

Palmetto: widely grown in California; claimed to be earlier than Conover's, also more productive and uniform in size; quality fine; especially favored for fresh shipments from southern California.

Argenteuil: also called "Giant Argenteuil" and "Early Purple Argenteuil;" approved for shipping in Imperial valley, for size and colors of shoots and tenderness.

Barr's Mammoth, Columbian Mammoth, and Dreer's Eclipse have been approved for garden planting to some extent.

CHAPTER XIV.

BEANS.

THE BROAD BEAN.—*Vicia faba.*

French, féve; German, garten-bohne; Flemish, platteboon; Dutch, tuin boonen; Danish, valske bonner; Italian, fava; Spanish, haba; Portuguese, fava.

THE KIDNEY BEAN.—*Phaseolus vulgaris.*

French, haricot; German, bohne; Flemish and Dutch, boon; Danish, havebonnen; Italian, faginolo; Spanish, frijole; Portuguese, feijao.

THE SCARLET RUNNER BEAN.—*Phaseolus Multiflorus.*

French, haricots d'Espagne; German, Arabische bohne; Dutch, Tursche boon; Italian, fagiuolo di Spagna.

THE LIMA BEAN.—*Phaseolus lunatus.*

French, haricots de Lima; German, breitshottige Lima bohne; Italian, fagiuolo di Lima; Spanish, judia de Lima.

THE BLACK-EYED BEAN.—*Vigna sinensis.*

A cow pea.

THE TEPARY BEAN.—*Phaseolus acutifolius;* var. *latifolius.*

THE SOY BEAN.—*Glycine hispida.*

Of the vast numbers of bean varieties known to horticulture, California grows but very few. Market gardeners of different nationalities, ministering to their compatriots among our citizens, have brought to California many varieties which they esteemed in their old homes and grow them here in limited quantities, but the general markets and the gardens and fields of Americans can show but few sorts. This is due in part to the indisposition of the people to try culinary experiments and in part to the fact that some varieties have shown peculiar climatic adaptations and are, therefore, better from a grower's point of view. But though few varieties are grown, some of them are grown on a very large scale—to such an extent, in fact, that five counties on our southern coast win for California the distinction of being the greatest Lima bean producing country in the world.

The capacity of California for production of beans is apparently limited only by the extent to which the produce can be profitably sold. Whenever there is a falling off in local production of the common varieties east of the Rocky mountains, California shipments are freely made, and when, many years ago, there was a full train-load sold for Boston, California embraced not only the profit thereof, but the proud satisfaction that she was really doing something worth while for the maintenance of the intellectual standard of the country. Train loads of beans have now become too common to attract notice.

FIELD CULTURE OF BEANS IN CALIFORNIA.

Though California has great bean producing capacity, the area well suited to the product is comparatively limited and only a fraction of that has conditions which favor the Lima bean as a field crop. Making deductions from years of local experience it may be stated that the summer heat and drought of the interior plains are offensive to most varieties of the bean plant; that occasional frosts preclude the winter growth of the crop over wide areas where ordinary winter temperature and moisture would favor it; that summer heat and drought modified by exposure to ocean influences or by influences existing on interior river-bottom lands, are acceptable to the plant and in such situations is the chief production. From a commercial point of view it is also quite important that toward the end of the season there should be a reduction of the amount of moisture in the soil, so that the plant may cease its growth and mature its seed before frosts occur or the fall rains make the harvesting difficult and stain the beans. Favoring conditions are thus seen to be quite exacting. During the growing period of the plant there must be: first, no frost (except in the growth of varieties of the Broad Bean, which are measurably frost resistant); second, the least possible duration of hot, dry winds, and a moderated atmospheric aridity generally; third, adequate moisture both in air and soil to maintain healthful vegetative verdure followed by a dry-soil-ripening period just as soon as the vines have filled pods enough for a paying crop.

Local Adaptations to Bean Growing.—These conditions are prescribed for a bean crop of the dry seed. They are all found in eminent degree on the coast sides of six counties: San Luis Obispo, Santa Barbara, Ventura, Los Angeles, Orange, and San Diego, and these counties produce perhaps three-fourths of the commercial bean crop of the state. Of course extensions of the region both north and south along the coast have similar conditions though in less degree—deficiency enough to warrant the remanding of the chief crop to the region named. Favorable conditions disappear with even greater rapidity toward the interior. Each of the counties is disposed on both sides of ridges of the Coast Range mountains. The ocean-side lands produce the beans; the interior valleys of the same counties, perhaps not over fifteen miles away, are beanless. The mountain ridges exclude the ocean breeze and the occasional fogs and mists, and bean plants would perish from dry heat before a crop could be made. On the other hand, on the ocean side of the mountains, beans are planted in May, after the rains are practically over, and the ocean tempers heat and furnishes moisture to the air, so that, by conservation of soil-water by good cultivation, the crop is often made without a drop of rain from seed to harvest.

On the moist or irrigated lands of the interior where heat and atmospheric aridity are tempered by evaporation from large supplies of fresh water or moist soil, there are also conditions which suit some varieties of beans very well, and good crops are made. But on interior lowlands there is often a summer rising of moisture from rivers, bank-full from melting mountain snows or other sources, which interferes with proper ripening of the beans by pushing the vegetative growth of the plants when they should be maturing a crop already formed. If, then, early rains come, the bean grower is apt to be caught with his work unfinished and his beans stained or sprouting. However, these troubles are not serious enough to cause the forsaking of the crop, and in an occasional year of drought, when the southern coast counties do not get rainfall enough to make their full crop, the grower on the interior lowlands records a good profit.

The market value of the field bean product of California for the year 1916 is placed at $20,000,000, as noted at the close of Chapter I. The great valuation is largely due to the high prices prevailing. Quantities are estimated as follows:

	Sacks
Limas, sacks of 80 pounds	1,815,000
Pinks, sacks of 85 pounds	825,000
Blackeyes, sacks of 80 pounds	250,000
Small Whites, sacks of 90 pounds	750,000
Bayos, sacks of 85 pounds	100,000
Large Whites, sacks of 92 pounds	150,000
Cranberry, sacks of 80 pounds	150,000
Red Mexican and Kidney, sacks of 80 pounds	50,000
Totals	4,090,000

Other estimates of annual crops are as follows: 1916, 3,600,000; 1915, 3,868,000; 1914, 2,905,000; 1913, 1,165,000; 1912, 2,013,000; 1911, 2,825,000; 1910, 1,950,000; 1909, 2,340,000 sacks averaging 80 pounds each.

At an estimate of 20 sacks to the acre the acreage in beans in 1916 was 180,000. The crop of 1917 has much larger acreage owing to war prices and exhortation to the greatest possible production.

Soil for Beans.—A rich sandy soil, if it can be kept moist enough, is best suited to the growth of beans, and dry, hot, sandy soil is the worst, but even on sand near the beach, fair crops are sometimes made by the help of aerial moisture and coolness. The plant does not require very great amount of moisture, if heat and atmospheric aridity are not too great, but it insists upon a certain amount. Crops have been lost by choosing land that was too wet. But though a light soil seems to best suit the plant, it can be successfully grown on any good garden soil, providing good cultivation is given and the land kept from baking and drying out. With adequate care in this regard, very good garden crops are grown even on adobe soil, but the commercial bean crops are grown on light soils because there are obvious cultural advantages in dealing with such soils.

Preparation of Land for Beans.—As our chief crops of beans are grown without irrigation on light soils, in regions of moderate rainfall, the preparation of the soil should begin at the opening of the rainy season, so as to prepare the land for receiving and retaining the maximum amount of the rain that falls. Growth of weeds after harvesting the beans should be prevented by cultivation, because weeds draw upon moisture and would produce seed for more weeds. This cultivation also opens the surface to absorb the early rains. When the soil is well moistened by rain, usually not later than January, a good plowing is given, and after that the chisel-toothed cultivator and the harrow or other tool fitted to break up all compacting of the soil at or below the surface, are used at short intervals through the winter to prevent evaporation, and retain moisture near the surface. There is some variation in winter practice, as some plow deeply, some turn a shallow furrow, and some low plowing. In all cases the end in view is the same, to bring the land to planting time with moisture retained and mellow to receive the seed.

Artificial inoculation of soil for beans is not usually found necessary in California, probably because bacteria are abundant from the previous growth of native legumes.

Time of Planting.—Hints of this consideration have already been given to illustrate other points. As a general conclusion it may be added that California experience clearly points to undesirability of early planting simply to keep abreast of the calendar. Most of our commercial beans are of the phaseolus varieties (kidneys, Limas, etc.), and they are tender and cannot be planted until frosts are over in each locality. The broad beans, especially the Portuguese bean, are more hardy and in some districts grow all winter, except in low, frosty places. The bush beans are hardier than the climbers and can be safely planted earlier, but there is nothing to be gained in planting either in advance of a good condition of warmth and moisture in the soil. Rather than trust the seed to soil which is too cold or too wet it is better to wait a little, kill the weeds by shallow working, place the seed deep enough to insure its contact with moisture and then trust to the more rapid growth of the plant to make up for the delay. This it will usually do, and will shoot ahead so that it will be of good size for cultivation by the time the weeds need another cutting. Just the time when the proper soil conditions may be expected to arrive will differ in the different localities, according to local rainfall and spring temperatures, the beginning of the frost-free period, the nature of the soil, etc. As a generalization, however, it may be put at May 1 to May 15 on the coast, with a range of May 1 to July 10 for interior lowlands in the central and northern parts of the state—chiefly to allow moist lands to come into planting condition, or to defer bloom-ing until the hot spells of June and July are passed. Such late planting is only safe on moist or irrigated lands in places where early fall frosts are not to be expected. Late planting is believed to reduce the danger from red spider.

As to condition of soil and weather at planting Lima beans, in the coast regions where they are grown, it may be said that ample heat in connection with soil moisture is necessary to start this variety, and planting is rushed during a warm spell to insure these conditions. A rain after planting is counted a detriment, for if the temperature of the soil falls too low the seed is apt to rot. Besides a shower means more weeds, and some large growers count it cheaper to plow up the field and replant than to clean out the weeds in the rows. Small growers, however, usually undertake the hoeing rather than sacrifice the plant if the stand is a good one.

Manner of Planting.—All commercial crops of beans, whether of bush or running varieties, are grown in rows. The planting is done with machines of different makes and sizes, though usually planting from two to four rows at a time. Depth is determined by the character of the soil and the season. The bean must be placed in moist soil, and if the surface is light and prone to dry out quickly, the greater depth is given, but the bean does not endure as deep covering as some other large seed. In a moist surface an inch will do, but in very light surface two inches is better. In some cases even a little more is desirable. It must be remembered that a few days' moisture must be assured to the seed to allow it to take hold of the soil.

In light soils liable to strong winds, the planter should run at right angles to the course of the wind, for it has been observed that the sand is more easily shifted when the wind has the lengthwise course of the drills.

Distance is dependent upon the variety. Lima beans are usually placed in rows about forty inches apart, with the planter rigged to drop seed at an average of about ten inches apart, in the row. Small beans of various kinds are given two to two and one-half feet between the rows, and about four inches distance in the row.

Once Over the Ground at Planting.—On land disposed to pack under heavy tools bean crops have been put in on land plowed the previous fall in this way. At the planting time in the spring use a bean chisel, pulled by a tractor, with a harrow hitched on behind, then a bean planter of multiple style and behind that a drag. This does the plowing, the cultivating and planting, and drags the land to keep the moisture in, all in one operation, and so does not begin to pack the soil as much as if two or three separate operations were made.

Cultivation.—Frequent cultivation with knife-shaped teeth, is practiced in the best bean soils, to kill weeds and loosen the surface, until the running varieties cover the space so that they would be injured by cultivation. The vines then cover the ground and check evaporation and the crop is left to its own course. With bush varieties longer and deeper cultivation is desirable, at least if the ground is apt to become compact, so that the earth-mulch described in the chapter on cultivation is maintained. One grower at Marysville, who gets a very large yield of Lady Washingtons, starts in with chisel-toothed cultivators as soon as the rows can be determined and continues at four- or five-day intervals as long as the cultivators can get through the rows. Eight to ten cultivations are given, the cost being about 35 cents an acre for each cultivation, $3.50 an acre for the season, which he considers a good investment for a greater crop.

Irrigation.—Except on low moist land bean crops are usually considerably increased by irrigation. A long run of a small head of water in furrows between the rows is the common method, and one or two irrigations as needed in June and July are counted sufficient.

Gathering.—Gathering the crop cannot usually wait until all the beans have ripened, for fear of shelling out the earlier maturing pods of some varieties, and for fear also of the fall rains already mentioned. Cutting should begin when the grower's judgment tells him he is about midway between the two dangers. The date will, of course, vary in different localities. The Lima bean has a longer growing season, and on the south coast is liable to encounter serious hot spells in August or September after other beans are matured and beyound injury. This heat shrivels the immature pods and lessens the crop.

Hand pulling or cutting of the vines, or plowing out, is no longer practiced in larger fields. A cutter operated by horse power is generally used. Two planks are framed and braced in sled-form, with cross pieces on the top, about four feet apart. From each, on the inside, a steel blade projects diagonally toward the center, some two feet, being fastened to the bottom of the sled runner. Two or three horses are hitched to the sled, which encloses two rows of beans; the blades of steel cut off the vines beneath the surface and push them into a central windrow so that they are readily gathered with pitch-forks and are thrown into heaps. Another form of bean cutter is a sled armed with knives six feet long which come together in front and spread far enough behind to cut two rows at once. With these outside cutting knives the sled is not over two feet wide. Some growers aim to have these knives run in the loose surface soil at a depth of about two inches; others run them deeper—along the top of the firm earth below the cultivated layer.

There are some local variations in the form of the "cutter" or "harvester," and in some cases an iron-frame cutter constructed on the model of a V-shaped cultivator with guiding wheel is used. Recently manufacturers have designed improved forms of bean cutters which are displacing the old home-made contrivances and are much more capable in handling heavier growth of vines such as are made by "black-eyes." Growers of large bean acreages should study carefully to determine what devices are locally used with greatest economy and success.

The beans are allowed to be in the field in small piles for two to four weeks, according to the curing quality of the local climate, until the vines are well dried. This not only facilitates the opening of the pods but saves the beans from staining by contact with green leaves or by the damp dust they gather.

Threshing-floors.—The early method of threshing was by the of the threshing-floor, and it is still practiced or held in view to prevent excessive charges by machine owners. It is tedious work, requires many animals and exposes the beans to greater injury by early rains. A threshing-floor is made by wetting down a circular piece of ground about sixty or eighty feet across, tramp it with horses and wagons until smooth and hard; then cover the floor with straw for a few days until it is dry, when it is ready for the beans. The first flooring of beans is put on deep, so the horses' hoofs do not cut the floor. Care should be taken all the time during threshing not to cut the floor. Two or three big wagon loads of beans are placed in a ring on this floor during very dry, clear weather. Formerly horses attached to light wagons were driven over the beans (usually two or three teams at a time), till they were all shelled from the pods. The vines are then thrown off and more beans from the field brought on. This process is continued until there are many tons of beans on the floor under those that are being threshed out. After this the whole mass of chaff and beans is run through winnowing and screening machines and the beans placed in sacks of seventy-five to eighty pounds each and are ready for market. Of late years the teams on the floor are attached to disc machines instead of wagons, which greatly facilitates the work. The use of a large roller on the threshing floor is preferred by some growers.

In suitable weather tramping is a less expensive method than threshing by machinery, but there is far greater danger from sudden storms of rain, as beans on the tramping-floor are in the worst possible shape in wet weather. Beans in the field can stand an inch or two of rain without much injury, if allowed to thoroughly dry before threshing. But beans wet on a tramping-floor while mixed with pulverized leaves are irreparably damaged, being stained and heated before it is possible to clean them. Every farmer who tramps out his beans should be provided with sheets of canvas sufficient to cover all unwinnowed or sacked beans liable to be left out during a shower. During extreme dry weather beans can be tramped well, the pods being dry and brittle while the vines are still green and tough, a condition in which a machine cannot work in them at all.

Machine Threshing.—For many years attempts were made to use modified grain threshers for separating beans. At first there was too great a percentage of cracked beans, but latterly machine work has become more satisfactory. The following account of bean threshing is prepared by L. W. Fluharty:

> The threshing is usually done with the bean huller, using either a steam or gasoline engine for power. The huller is a double threshing machine. There are two cylinders, one of which is placed in the rear of the other. The rear cylinder operates much faster than does the front one. The cylinder teeth are set one-fourth of an inch farther from the concave teeth than in the regular grain separator. The front cylinder threshes only the beans from the driest pods. The vines, together with the tougher pods pass to the rear cylinder, thus the beans and the tougher pods are threshed by the high velocity cylinder while the dry beans pass through only the one running at a low rate of speed. Much cracking is prevented by this arrangement.
>
> A grain separator may, by proper manipulation, be made to do very satisfactory work provided the vines and pods are nearly uniform in dryness. All but one row of concave teeth and generally half of the cylinder teeth are removed. The cylinder is run at a speed of from 350 to 400 revolutions per minute, the speed depending upon the diameter of the cylinder—the larger the cylinder the slower it must be run. The drive pulley is enlarged so that the separating part of the machine runs at the usual speed for separating grain.
>
> The tailings from the sieves are returned to the separator at the rear instead of in front of the cylinder. By this arrangement none of the threshed beans pass through the cylinder the second time. If there is a large amount of green pods the tailings are sometimes taken from the machine at the bottom of the elevator. In this way it is often possible to avoid mixing the green beans with those that are ripe. If the regular grain separator is used the threshing should be done while the vines are in the sweat, for at that time the seed is tough and not easily cracked.

The beans are gathered into header wagons, with beds ten feet wide and sixteen feet long. One side of the bed is considerably higher than the other, and a large and strong net is spread over the entire bed, fastened on one side, and into which the beans are forked. This is driven to the threshing machine, where a derrick lifts up the lower side of the net and tumbles the contents onto a large platform, after which the straw and beans are fed into the machine with pitchforks. It requires eight header wagons to keep the machine busy. Fifteen hundred sacks, averaging seventy pounds each, or one hundred and five thousand pounds, is considered a good day's work.

The machine-threshed beans have also to be recleaned before they are marketed. Yet there is one great advantage with the steam thresher. The rainy season is approaching, and a shower is liable to fall in October while the threshing process is in full blast, so that any beans that are caught on the floors are ruined if they do not manage to cover them in some way, while by the machine process all beans are sacked as they are threshed.

Bean Cleaning.—It is imperative now that beans should be put into good marketable condition. When prices are high the quality and condition of the beans does not materially interfere with the sales, but in times of plenty, the best is hardly good enough and the most scrupulous attention is given as to the quality. To insure the most ready sale at best prices, every grower should have the reputation of putting his beans in the sack for sale in thoroughly sound and clean condition, even by hand-picking if necessary. A dirty lot of beans from any locality injures not the grower alone but casts suspicion on all the product of that place. In preventing this, associated effort of growers has accomplished much.

Bean Bugs.—Three insects particularly bother the grower. They are weevils, red-spider and thrips. The weevil is started in the green growing bean, the egg being laid on the seam of the pod when small. Beans should be gathered as soon as ripe. If there are then bean larvae working on them, they can be killed by heating the beans to 130 degrees in the oven, but of course one must not get higher heat if it is expected to plant any of the beans next year. The larvae can also be killed by putting the sack in a tight barrel and pouring carbon bisulphide into an open dish on top of the seed. An ounce for each 75 to 100 pounds is recommended. As the fumes from the liquid settle among the beans, all of the weevils are killed. The gas should be allowed to act from 24 to 36 hours, and as it is highly explosive it should not be exposed to artificial light or fire.

If the growing plants have whitish or yellowish leaves with roughened surfaces either red spider or thrips, or both, are at work. Red spider is destroyed by dry sulphuring the foliage. Thrips require spraying with a soap and nicotine wash such as is described in Chapter XXXVIII.

Rotation of Crops.—It has been the experience of bean growers hitherto that many crops of beans can be grown successfully on the same soil without great difference in the yield—that is, the land does not clearly show wear, and some claim that following crops are better by growing beans after beans. It is clear that following a bean crop improves barley, potatoes or other succeeding crops. This might be expected from what is now known of the power of the legumes to fix atmospheric nitrogen by means of their roots. Our best bean soils are so rich naturally that they are able to endure a long cropping period and growers are apt to look upon the soil as a constant factor and wish that the weather could be placed in the same category.

VARIETIES FOR FIELD CULTURE.

The Lima Bean.—The Lima is the great bean of California so far as the outside world is concerned, because though other beans are grown everywhere, a small area of our state, as already mentioned, is especially adapted by its favoring local climate to the growth of this rather exacting variety. The variety grown is the old "Large Lima," well known to the trade and well adapted to the region, and however popular the dwarf Limas may become as garden varieties they do not promise to supplant the old sort in its stronghold. Improved strains are being secured by selection by several Ventura county growers, and much greater yield to the plant is foreshadowed. Though the Lima is a running bean no support is given it in field culture. It is safe and comfortable reclining on the dry, warm soil, with its verdure always freshened by the breezes of the Pacific, which lies in plain sight of most fields. Thousands of acres are thus laid out green and level as a meadow to the distant viewer—the scene unmarred by fence or other obstruction, for the fields are usually subject to no unwelcome intrusion except hot blasts of air which rarely beat back the ocean breeze and harm the plant. In most years without a drop of summer rain and held in heart by the insensible ocean vapor and occasionally by fog and mist, the Lima bean often yields the growers an average of a ton to the acre of good land, and sometimes does more than fifty per cent better than that. On large, uneven tracts, the average would, of course, be less. In 1911 in Los Angeles county 1,364 acres yielded 22,000 sacks—about 1,300 lbs. to the acre. During recent years, preceding the European war, the price of Lima beans had been reduced, but there still remained a narrow margin, because production was accomplished at less cost through improved methods and machinery. There is also an association of Lima bean growers which is assisting producers to secure all that the market will warrant. Lima bean straw is an important by-product, as it sells readily to stock-feeders at $4 to $5 per ton, according to the demand in different years—and in a time of scarce fodder has sold as high as $15 per ton as a substitute for hay.

The Small White Bean.—This is the accepted local name for the variety which is called the Navy bean at the East. The seed was brought from the state of New York as far back as 1852. The Small White has a polished or varnished surface which prevents rapid absorption of moisture. This not only especially fits it for shipping by sea and gives it great keeping quality, but it enables the bean to hold its form through cooking processes. Large quantities are shipped to Boston, where they are used in preparing "Boston canned beans," which are sold all over the United States. The Small White Bean is chiefly grown in Monterey, San Luis Obispo and Santa Barbara counties.

The Pea Bean.—This is another Small White bean which was introduced into California early in the fifties. The variety has a very thin transparent skin which admits moisture readily and is apt to disintegrate in cooking. The Pea bean is grown along the Sacramento river and in Ventura county, but not in large amounts.

The Large White Bean.—This variety is also known as the Lady Washington. At the East it is rated in the trade as a medium bean; it is a little larger than the Small White. The seed was introduced from the East in early times. The variety is chiefly grown in the Sacramento and San Joaquin river country and in the central coast counties.

The Bayo Bean.—There are two varieties grown. the Bayo Grande and Bayo Chico. The former is large, the latter small; both are brown. The seed came from Chile in 1849. The Bayo is chiefly grown in the Sacramento and San Joaquin river region.

There is also a dark red bean which was brought from Chile, and usually named from its color.

The Pink Bean.—This variety is sufficiently described by its name. It has been in California so long that its origin is unknown, and our best bean merchants have never seen it from any other source than this state. It is a first-class bean, and the citizens of Spanish descent prefer it to all other varieties, and it is largely grown for their use in San Luis Obispo county. It is grown to a considerable extent in Sacramento river lands and is perhaps the most successful variety at points in the San Joaquin valley. It holds place also in the southern coast district.

Mexican Red.—Like the Pink, but darker colored, and like it, hardy and productive under different conditions.

Cranberry.—Another pink and red bean which is gaining some standing as a dry bean.

Red Kidney.—An old garden variety chiefly in demand by canners. The largest colored bean but not largely grown.

Tepary.—A small, white bean from Arizona, believed to be of ancient origin and fully discussed in the publications of the Arizona Experiment Station. It recently became widely popular in California because of its heat resistance and heavy bearing in interior valley situations, which distress most of the widely known varieties. Its commercial standing is not fully determined.

The Butter Bean.—This is the local name for what is known as the "Flageolet" in France, whence the seed was brought to this state. It is large, white and flattish. It is going out of production here, as the seed is apparently running out, the size being only half that of thirty-five or forty years ago.

The Black-eye Bean.—It is thought that this variety came from Virginia. It is grown in all the leading bean districts. This and other of the "cow pea" group are grown to some extent, as a cover crop for plowing under, in the citrus orchards, and a seed crop is also sometimes harvested in the citrus districts.

The Soy Bean.—This Asiatic species, which has many varieties, is grown to a limited amount by Chinese and Japanese on river bottom and reclaimed lands, both for forage and food.

The Horse Bean.—A broad bean, chiefly grown by Portuguese in the San Francisco Bay region; hardy and prolific, making free winter growth where freezing is quite sharp. The beans are very subject to weevils and, therefore, are in bad commercial repute. They are now being widely grown for green manuring as they use surplus rainfall moisture. They are upright growers and ordinary bean harvesting methods are not generally used. The stalks may be cut with hand sickles but a combined self-raking reaper is sometimes used. The dry crop is used for stock-feeding.

The Castor Bean.—Though the Castor bean is inedible, some reader may expect its name to carry it into this connection. As a profitable crop the Castor bean has been a disappointment. There were more Castor beans grown in California before 1875 than there have ever been since. The price has always been limited by what oil-makers had to pay for beans laid down here from Calcutta, and that was too low to meet high labor cost in California. There is a long ripening and drying season in California, but the crop requires much hand labor cutting the clusters as they reach condition all through the fall, and in drying the clusters so the beans will pop out. Oil makers will not pay enough to cover this cost. The large ornamental Castor bean plants which are abundant in this state are not the oil-making variety.

GARDEN CULTURE OF BEANS.

Much that has been said about the field growth of beans applies to the garden culture. Condition of soil and time for planting are practically the same, and so are the characters of the growing season, except that the gardener cares little for the maturing of his crop, but prefers a green succession. A condition of late summer moisture, then, that would be a serious trouble in the field, is an advantage in the garden. For a product of beans as a green vegetable, the drying out which promotes maturity is to be prevented, and if this is successfully done, either upon naturally moist or irrigated land, the bean plants will continue their yield of green pods until frost cuts them down. As California has, as a rule, a very long frostless season, the bearing season of green pluckings may cover several months.

In frostless places, or in places of light frosts, where the grower affords slight protective covering, the bean continues its growth and bearing into the winter and vines of some varieties assert their perennial character. Even where the frosts cut down the top, some of the phaseolus varieties maintain their life and start again freely from the old roots when the spring warmth invites activity.

The continued growth of the bean late in the fall, in the absence of frost, sometimes affords a better late than early crop, because certain insets which destroy the early blossoms cease from their labors, or because too high heat no longer blights the bloom. It is often the reward of the amateur gardener, who promotes late growth of his bean plants by continued irrigation, to gather ample supplies of tender pods when less diligent growers have none. Midsummer bean planting on moist interior lands is also a good practice, as it gives the plant a growing season in the fall when the hot and dry summer conditions are relaxed.

The planting of beans in frostless situations in the fall for a winter crop is, of course, a limited enterprise, and attended by considerable risk, because *never* having a frost, means *hardly ever,* and yet good returns are often made in a few places already designated in the chapters on climates and the planting season.

The winter preparation for field planting on the light soils that are mainly used for that purpose will do for the same soils and situations for garden growth, but where beans have to go upon rather heavier soil in regions of heavier rains, it is necessary to give more thorough spring cultivation to overcome the compacting of the soil by the rain, and make it suitably mellow for the crop. For this purpose, spring plowing twice, the second shallower than the first, and good harrowing following the second plowing, are desirable. All this work should be done when the soil works freely, and only then.

In rainfall garden practice, where moisture is short, the land should lie in shape for taking in water all during the earlier part of the rainy season, and not be cropped nor left hard for the spring working, but where moisture is ample, the land may carry first a fall-planted crop of hardy vegetables for winter use, provided this crop is cleared away by February and the land put into condition to store up the spring rains for the use of the beans. This practice depends upon the likelihood of the late rains being generous, and the soil being retentive enough.

In garden practice young beans are quite subject to "damping off," as discussed in Chapter XI. The lower part of the little stem, from the ground upward for a couple of inches, loses color—becoming limp and palid and the upper part wilting and dying afterwards. The preventive is to allow the soil surface to become dry, which may be promoted by cultivation, as soon as the seedlings appear, or by sanding the surface around them. It is much less likely to occur when a good deep-soaking irrigation is employed instead of frequent sprinkling, which keeps the surface too moist.

Bush Beans.—Varieties of this class are hardier than most climbing beans and are safely planted earlier—perhaps from one to two weeks usually, but they should not be planted until the soil becomes warm and loses its excess of water. For hand-hoeing the rows can be fifteen to eighteen inches apart, and for horse cultivation two feet. About four inches apart in the drill, and covered from one to two inches, according to soil and season, is ordinary practice. The plants can also be grown in hills. If the ground is in good condition the seed can be planted before the lighter frosts of spring are all over, and by slight covering they can be carried through. The bush varieties will endure more cold and more heat than the climbing sorts, but any considerable planting should wait until the frost danger for the locality is over. Later plantings should be made at short intervals, for succession and irrigation must usually be resorted to quite early in the summer, except on moist land or on the immediate coast.

Bush beans are usually divided into two groups: those with green pods and those with waxen, or light yellow pods. The following are favorites in this state:

Early Mohawk, hardy and early for early crop, large flattish pods.

Dwarf Horticultural, or Cranberry, vigorous grower, large leaves; pods medium, curved; beans pale pink, marked with red.

Burpee Stringless, Green Pod, early, straight, roundish pod, brittle and stringless.

Extra Early Valentine, said to be fit to gather in thirty-five to forty days from planting, green pod, medium sized, fleshy, keeps green longer than most kinds—a favorite in the Sacramento valley.

Extra Early Refugee, popular with early vegetable shippers, round pods, bright green, very productive, largely grown in Vacaville and other early regions.

Long Yellow Six Weeks, pods long, early, very productive, excellent quality; popular in southern California.

Golden Wax, early, strong grower, long pods, very brittle and stringless, popular in the Sacramento valley, coast valleys and southern California, where it is commended as most likely to come through from late planting.

Canadian Wonder, long, straight pods, not stringless, but acceptable; seed dark red. Especially hardy and adapted to winter growth through light frosts. Good for early and late planting and profitable; maturing during long shipping season.

Ventura Wonder Wax. A California variety; very stocky growth and prolific; pods long, flat, yellow; beans white.

Davis White Wax, broad pods, clear light yellow, productive, tender and delicate flavor.

Wardell's Kidney Wax, long, flat and showy tender pods, strong grower, prolific. Beans shapely, pure white with purple eye; little later than Golden Wax.

Prolific Black Wax, long and large pods, golden color, very productive, bearing early and through a long season.

Burpee's Bush Lima, reported by California growers as the best of the dwarf Limas.

Broad Beans.—These beans are related to the so-called horse bean, but by breeding have lost much of the strong flavor of the horse bean, and have so increased in size of the seed that they are several times larger than the horse bean. In Europe they are esteemed as a highly nutritious and palatable vegetable. The seeds only are eaten and are prepared for table in much the same manner as Lima beans. As Lima beans are more delicate in flavor and nearly always available in California markets there is less chance for broad beans than elsewhere, and yet the fact that they are more easily grown gives them claim to attention. The plants are productive and will flourish in almost any locality. The seed should be planted about three inches deep in double rows, eight inches between the rows forming the double line, four inches between the plants in the rows, and three feet between the double rows. The early formation of seed can be hastened by removing the terminal bud of the plants when they have reached the height of between four and five feet, and have produced enough flowers to insure a good crop of pods. The Green Windsor is the best known broad bean.

Climbing Beans.—Pole beans are usually more susceptible to heat and drought than the better bush varieties, and they are disappointing in other ways. Near the coast, however, they may be grown and trained in any way the grower pleases, from a six-foot staff to a whole wigwam of poles and strings. In the catalogues of California seedsmen many good varieties for amateur trial are described. The best climbing bean for most California situations is the Kentucky Wonder, or Old Homestead, which bears a mass of pods when grown to a six-foot stake. It is quite hardy and can be safely planted a week or more before many other varieties. It is a medium early bean and takes very readily to the poles; wonderfully prolific, the vines being actually loaded from top to bottom with pods from six to nine inches in length; as string beans, the pods are nearly round, tender and very solid. The White-seeded Kentucky Wonder has recently become popular with market gardeners because its pod-color is very attractive and it is said to be more resistant of mildew. The Gray-seeded Wonder is also esteemed. The Case Knife and the Asparagus or Yard Long are also excellent climbing beans; the latter especially as a string bean.

Trellising Beans.—Instead of unsightly crooked poles, subject to being blown down and always to be set up in the spring and stacked in the fall, always to be renewed about every four years, set six-foot posts about a rod apart through the beanfield and string a wire over the tops of them above the rows of beans. The end posts are braced. A cotton string is hung from the wire to the ground at each hill of beans, 15 inches apart. The strings support the vines till they reach the wires where they make a neat hedge effect with just room between the rows for pickers.

Perennial Beans.—It is not unusual for the California gardener to find when he is digging over his bean ground in the spring that the old roots of the preceding crop are not dead but are making new sprouts. One grower in Alameda who had this experience was adventurous enough to save these roots and got a second year's crop from them. Afterward he transplanted such roots, mulched them in the winter and finally had bean plants two, three and four years old, bearing profusely and making from two to four vines from each root, growing twelve feet high, and yielding heavily. The crowns of such roots are often about two inches in diameter. These beans are usually of the scarlet runner class, though some of the white climbing forms have perennial roots. In an amateur's garden they are very interesting and useful in places where frosts are over before heat enough comes to start the top growth from the perennial roots.

Transplanted Beans.—Beans may be easily grown early in moist sand in a protected place and set out when several inches high when the soil and air are fit to receive them. The best way to get a good start in a family garden is the method of Mr. Adams, described in Chapter XI, by which a whole hill is moved from under cover to open ground at one operation.

Growing Beans in the Irrigated Garden.—Beans may be irrigated in any of the ways described for garden practice, according to the character of the soil. They will stand flooding of the ground, if it is done at sundown. They will also grow well on the ridge systems, either with water above or below, according to the soil. Shallow planting should be done when the ground is to be kept moist by irrigation.

CHAPTER XV.

THE BEET.

THE BEET.—*Beta vulgaris.*

French, betterave; German, runkelrube; Dutch and Flemish, betwortel; Danish, rodbede; Italian, barbabietola; Spanish, remolacha; Portuguese, betarava.

LEAF-BEET OR SWISS CHARD.—*Idem.*

French, poiree, German, beisskohl; Dutch and Flemish, snij beet; Danish, blad bede; Italian, bieta; Spanish, bleda; Portuguese, a celga.

The beet as a garden vegetable is taken from the ground every day in the year in California. It can be sown at almost any time, and at all stages of its growth is uninjured by any temperature which is experienced in California valleys. Moisture conditions do, however, affect its growth. It is unwise to sow the seed in cold, wet ground, but if the seedling has taken hold it can endure extremes of saturation or drought for a long period, and it is not injured for any purpose by standing where it has grown for a considerable time after it has reached its first maturity. The beet is counted, however, rather a coarse vegetable, and would be consigned to rather a lowly place did not its present achievements and its greater promise as a source of sugar give it commanding importance. Though our people are somewhat chary about putting the boiled beet-root in their table china, they do not hesitate to install in cut glass or silver bowls the solid extract of beet-root in the form of sugar cubes or granules. The industrial importance of the beet includes also its value and availability as an auxiliary cattle food, and it is all the more esteemed for that purpose because in our climate it needs no root-cellar or even earth-covering, but is pulled all days of the year, fresh and succulent, from the site in which the seed was cast months before.

THE GARDEN BEET.

Though, as stated, the beet is hardy under all our conditions, it needs for the proper germination of its seed moist, warm ground, and it makes rapid and tender growth with the same soil conditions. In cold, wet soil or in hot, dry land, it will grow slowly and will be tough and of inferior flavor. Though it is true that beets will endure much drought, growing slowly and rooting deeply on land where grain and hay would fail and subsequently, with the coming of the fall rains, assume more active growth and reach large size for the winter feeding of stock, it is not in that way that tender and sound-flavored table beets can be produced. They should make rapid growth from start to finish, and then they may remain in their places for some time without notable loss of quality, unless the ground is heavy, becomes saturated and retains water. In fact, some growers on well-cultivated upland loams claim that the beets improve in the soil and are sweetest and tenderest just before sending up their seed stalks. In localities with excessive rains, it is often desirable to gather beets and pack them away in dry sand, but in most places open air winter conditions do not make this necessary. On the other hand, as the seed may be almost continuously planted if moisture conditions are arranged, small planting for several successions should be the rule in the family or sale garden, if long use from one planting shows deterioration.

Garden Culture.—Beets may be grown in the hand-hoed garden in rows twelve inches apart, or even nearer than that if space is precious, but rows for horse work should be eighteen inches or two feet, as may be necessary to insure that the distance chosen shall bring the rows of upright growers uniform distances apart for ease of cultivation with implements that cover several rows at one passage. The small varieties popular in this state do not need that distance, but all narrow spacing is grievous in the use of horse tools.

The soil for beets should be well worked to allow natural penetration, for the beet has a taproot of great importance in its development. The seed may be soaked before planting if the ground is inclined to be dry, and should be covered from three-quarters of an inch to two inches, according as the soil is heavy and moist or light and dry. In late planting the seed must go down to moisture, and there is then little danger of rain compacting the covering. Planting may be done any time when the soil is moist and warm, but never when it is cold or wet. Seed may be spaced an inch in the drill approximately, but while still small the plants should be thinned to six or eight inches. The sooner this is done after the plants have reached a height of three or four inches the better. It is quite a common practice to allow the rows to grow thickly until the thinnings are large enough for greens. The practice injures the surviving beets, for they never reach quite the development they would if they had never been crowded, but with some the gain of the greens is a compensation.

Varieties.—The garden beets popular in California for table use are all the round or flat shapes, and all of red color.

Detroit Dark Red, globular, rich red flesh; tops small and green.

The Eclipse, an old favorite, is still of wide popularity. It is early and of good quality, and symmetrical, round form. Said to be better than others for late planting.

Crimson Globe, medium size, globular, smooth; small taproot and abundant foliage, protecting root crown.

The Extra Early Egyptian is of flat, turnip shape, very deep color, early, tender and fine.

Morse's Improved Blood Turnip, especially selected for style and quality, deep red, green tops.

A. & M. Bassano, commanded for tenderness and shapeliness and flavor. Popular with market gardeners.

Crosby's Egyptian, of flatter form than Early Egyptian, good for early use, but maintains tenderness well as it gets larger size, very bright clear red flesh.

Edmunds' Blood Turnip is another favorite market variety, round and smooth, deep color and good quality.

Early Blood Turnip is also largely grown. It is round, good form and quality.

Long Smooth Blood is an old standard variety for those who like beets for slicing. It roots deeply and stands drought well.

THE LEAF-BEET OR SWISS CHARD.

This plant is a beet grown for its foliage and not for its root, which is small and branching. Its cultivation is, however, exactly like that of the beet root, except that its rooting habit allows of shallow tillage, but it enjoys good conditions in the soil and manifests its delight by grander foliage, which is very desirable and is used as spinach is. Chard is not largely grown in California because conditions are so favorable for continual supplies of spinach, which is preferred, and yet many find it desirable. It is also grown for green feed for poultry in the autumn from planting as late as July.

THE SUGAR BEET IN CALIFORNIA.

All that has been said in preceding chapters on California climates and soils has direct reference to the exceptional adaptation of the state to the growth of the sugar beet and the manufacture of beet sugar. The vast area of rich, deep, loamy and easily-worked soils, which afford the plant deep rooting, free expansion and large yield of rich beets; the equable climate, which insures ample sun-action, freedom from low temperature, and an almost continuous growing season through the year for a hardy plant like the beet, and thus provides for sugar factories a maximum working season without protection of the rich, raw material from freezing—these are local advantages for beet growing and sugar making the importance of which it is difficult to overestimate. There are also many incidental advantages and benefits in ground which does not freeze and in factories where the absence of freezing temperature makes it unnecessary to build for protection of men, materials and machinery, except from heat and rain.

Extent of the Industry.—Eleven beet-sugar factories in California produced, in 1916, 243,800 tons of sugar, from 144,200 acres of beets. Large as this quantity is, it is small compared with the possible production in California, as there are seven hundred and fifty thousand acres perfectly adapted to the raising of sugar beets.

Allowing for proper rotation of crops, about two hundred thousand acres would be available each year—capable of producing two million five hundred thousand tons of beets and three hundred and fifty thousand tons of sugar.

In 1917 California has fifteen factories in operation or nearing completion. They are located in counties as given below:

Alameda	1	San Bernardino	1
Glenn	1	San Joaquin	2
Kings	1	Santa Barbara	1
Monterey	1	Tulare	1
Orange	5	Ventura	1

According to Professor R. L. Adams: "Some idea of the rapid development and resultant importance of the beet industry to the state may be gleaned from the fact that in the relatively short period of ten years the acreage has increased from approximately 60,000 acres in 1906 to an estimated acreage of over 144,000 in 1916. By three-year averages the acreage has risen from an average annual acreage for the years 1907-09 of 64,227 acres to 98,960 acres for 1910-12, and to 118,600 acres for 1913-15. Indications point to an increasingly larger area for the near future." *

Comparative statistics show that the proportion of saccharine is greater in the beets grown here than in any other locality, whether in Europe or America. The plant itself becomes a more active worker and extracts more sugar from California soil and sunshine than it does elsewhere.

Situations and Soils.—Of the fifteen factories cited ten are in the coast valley region south of San Francisco, one in the Sacramento valley, four are in the San Joaquin valley and the large area noted as adapted to sugar-beet production is obtained by computation of our valley acreage. For the most economical production of uniformly good beets, fairly level fields are of great advantage. To get the largest profits there must be the use of the most capacious planting, cultivating and harvesting appliances, and all these are best suited to level or gently sloping lands. As most of these lands, except in coast valleys, lie in regions of moderate rainfall there is seldom the need of underdrainage, but the problem is rather one of moisture conservation, and that is in most cases easily accomplished by cultivation, to the extent required by the beet which roots deeply and draws its moisture from a large soil volume. Where it may be necessary to concentrate the rainfall of two seasons for one crop, the method of a constantly stirred summer fallow, which insures a crop of grain in spite of low rainfall, will do the same for a crop of beets, providing the relatively deeper cultivation required by the beet is given.

Though nearly all fertile soils will grow good sugar beets if well tilled for moisture retention and for root penetration and expansion, a rich, mellow loam, deeply worked and with medium moisture conditions, is the ideal for the purpose. Sandy soil, which dry out in spite of cultivation, are available for beet growing by careful irrigation. Heavy, wet soils may be put into condition by underdrainage and cultivation, but there are such vast areas of soils which will suit the beet without either irrigation or drainage, it is probable that improvements in these lines will be left for the future.

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*Circular 165, Agricultural Experiment Station, University of California, Berkeley, on "Fundamentals of Sugar Beet Culture Under California Conditions."

Tillage for Beets.—Land for beets should be taken in hand early. If it has not been summer-fallowed the previous summer, it may receive a shallow plowing early in the fall, being left rough to receive the rainfall. As soon as the heaviest and coldest rains of the season are over in the locality a deep plowing should be given, so as to secure a seed bed of ten or twelve inches depth of stirred soil. This practice is best for coast valleys, where spring rains after the plowing are likely to be sufficient to restore to the soil a proper degree of compactness. In light, open soils, with scant spring rains, the first plowing should be deep and the second shallow for fear of leaving the lower strata too open. It is often good practice to rely upon one good plowing early in the winter, followed by the use of the chisel cultivator, harrow and clod-crusher, to bring the surface into fine mellow condition to receive the seed. Modification of methods must be made according to local soil and rainfall, but the condition to be aimed at is deep stirring, lower strata, moist but not wet, surface fine and moisture near it, but not disposed to bake or crust with rains, which may follow sowing.

Rotation.—Beets make a strong draft on some components of the soil, and it is a common experience that they should not be grown year after year for a long period, but should take their place in a rotation, in the course of which one or two crops of beets should be followed by a crop of grain or potatoes, and that, if possible, by a leguminous plant like beans, alfalfa or an annual legume like burr clover used for pasturage, and then to beets again. Beets improve soil for grain, because of the deep running of the root, and because beet culture is not profitable without deep plowing and continuous summer cultivation. This deepens and cleans the land to the manifest advantage of the grain crop, but still the beet reduces the plant food in the soil and some change of crop should be made with reference to its restoration, and this is the reason for the leguminous plant and pasturage if possible.

Planting.—Sugar beets are grown in drills about eighteen to twenty inches apart. Seeding is done with machines. Covering should be as shallow as will bring the seed into soil, which will remain moist; depth depends upon earliness of sowing, character of soil, as already explained in other connections. Sometimes it is desirable to cover as deeply as two inches; sometimes, and usually, perhaps, one inch or a little less. In late sowings, when the surface has become quite dry, an attachment to the drill which pushes aside part of the dry surface and brings the seed into moist soil without running too deep, has been found valuable. The greatest care should be taken to have the rows straight. Possibly most beets are grown in crooked rows, as it has long been said of corn, but the whole after course of the field is improved by running the drill straight. It is undesirable to have a rain just after planting, unless the land is very light and dry. If crust forms it must be broken by light harrowing or rolling.

The time of planting depends upon the local climate and the character and condition of the soil. With reference to local climates Professor Adams says:

> The commercial time of planting in California covers a period from October 1 until June 1, local conditions largely influencing the time when the seed is sown. In general, as near as a rule can be given, fall planting—October, November and December—is more common in the southern portion of the state; early spring planting—last of January and February—in the Sacramento and San Joaquin valleys; and later spring planting—February 1 to June 1—in the coast sections, such as Monterey and Santa Barbara counties. Local conditions will determine the best time to sow, but as a general recommendation, as early planting as is possible is to be strongly recommended. Although early planting carries with it attendant difficulties of soil preparation, weed destruction, thinning and hoeing, danger of root rot and crusting, the increased tonnage of beets obtained fully warrants early planting, even though it becomes necessary to replant occasionally. In the interior valleys where warm weather begins at an early date, early planting is absolutely essential to insure well-established growth before the heat and dryness of late spring and summer descend upon the fields.
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> In certain sections, especially in the Sacramento Valley and some of the central coast sections, it is possible to plant beets so early that a considerable percentage will throw up seed-stalks. If this seed formation progresses too far, the sugar content of the crop is reduced and the beets become too woody for profitable working. "Early planting," therefore, must be construed as meaning the planting of the seed as early as possible, while guarding against planting so early that seed production replaces satisfactory maturing.

Cultivation.—Weeds should never be allowed to get the start of the young beets; nor should the soil be allowed to lock them in a hard surface. For this reason cultivation should begin as soon as the rows can be seen. Very effective cultivators, or horse-hoes, have been designed by California mechanics, which make it possible to work two or four rows at once if the beets are in straight equidistant rows. This cultivation, beginning thus early, must be continued at frequent intervals, for the reasons already fully given in the chapter on cultivation. Cultivation is absolutely essential to a good beet; not only must moisture be conserved, but the lower strata must be kept reasonably loose so that the soil may be displaced by the expanding beet-root. This is done not by deep summer cultivation, but by keeping a good surface mulch to prevent evaporation, and the lower soil will then keep itself in good condition. All flattened, or knotty, or gnarly beets show that there has been slackness, either in proper depth, in preparation of the ground, or in lack of cultivation afterward, permitting deep drying out.

Beets which show signs of distress will be discarded or discounted at the factory. The beet must be symmetrical, smooth and fine—all of which are signs of thrift in a beet as they are in a well-bred animal.

Thinning.—Excellence in beets is also dependent upon each having adequate soil-room and plant food. It is impossible to get proper spacing by any scheme of seed dropping. It is necessary to sow too thickly in order to get a uniform stand; the spacing of the beets must be done afterward. By using a narrow hoe crosswise to the rows, the plants can be quickly thinned to clumps or groups, from which all but the strongest plant are pulled by hand. Thinning should be begun when the seedlings are small—say from two to four leaves. It is easier to do it well at this stage, and it is vastly better for the beets which are to stand, for it does not displace the soil nor disturb their rooting, as when it is done too late. Beets should stand eight to ten inches apart in the row, according to the soil. Where the soil is very rich and the beets likely to overgrow the two-pound average, which is most acceptable to the factory, they should be allowed to stand nearer in the row. After thinning, the surface cultivation must proceed for weed cutting and surface loosening until the beet leaves cover the ground. The field is then laid by until harvesting.

Irrigation.—Irrigation is the surety of proper development of the beet, as of other plants, though a large part of the California product comes through by rainfall. The grower must follow the discussion of this subject in special publications and become wise also by experience and observation under his own local conditions. It is becoming more and more clearly demonstrated that the beet should be brought to the thinning stage by rainfall or by irrigation before planting, if possible; also that water should be handled preferably in furrows to avoid the ill effects upon the soil and the plant by surface flooding. Irrigation should be stopped a month or so before harvesting to favor maturity and development of a good sugar content.

Harvesting—As the outer leaves of the beet turn yellow and drop to the ground, maturity arrives. It is usual for the factory to notify the grower when his crop is ready. The beet can stand long in the soil without losing sugar percentage, but the factory cannot use all the beets at the moment of their readiness, and, therefore, some growers have to wait for delivery until the opening of the rainy season, and that is not pleasant or profitable. It is desirable, therefore, that seeding should be done at different times, as each kind of land in the locality comes into condition, and thus prolong both the harvesting season and the factory season. On this point local advice should be taken from the contracting purchaser.

Beet harvesting is now done cheaply by means of implements and machines of California design and construction, which either loosen or completely dislodge the beet. Topping, or removing the leaves and all the green part of the root grown, is done with knives, though inventors are perhaps making some promising progress in machines for this work.

Beet tops are good stock feed if not allowed to become moldy and are sold at $0.50 to $4 per acre, as determined by the factory weight of the beets delivered. But wherever possible the beets should be fed on the land and the manure returned to the soil, or fed on a feed-lot if the soil is liable to be injured by tramping during the rainy season.

Yield.—Very large yields of sugar beets have been reported with perfect truth, and larger sugar percentages have been attained in California than anywhere else in the world, but average statements are a better guide than extremes. The statistics gathered by the U. S. Department of Agriculture show that the eleven factories operating in 1916 worked up 1,439,000 tons of beets which were harvested from 144,200 acres of land. The price for the beets was, on the average, $6.44 per ton, and the average yield was 10 tons per acre. The average gross return to the grower was, therefore, $64.40 per acre. The cost of production is variously estimated at from $40 to $50 per acre, leaving a profit of from $14 to $24 per acre. Of course, some make much more than the average. There is quite as large an opening for good farming in beet growing as in any other crop, and the beet seems to know as clearly when it is well off and gathers sweets like a bee.

Beet Pulp for Stock Feed.—The use of beet pulp for stock feeding has increased rapidly during the last few years, and promises to be as popular here as in Europe. It is fed fresh and is put down in silos. It is very cheaply siloed, because it packs down readily and it seals itself up from contact with the air by the formation of a surface crust. The pulp is also being commercially dried and sold in large quantities to stock-feeders. There are, however, many economic questions concerning the cost of the pulp, either as it comes from the factory, or dried, or as silage which are not yet fully determined, and which it needs systematic experimentation to demonstrate.

Varieties.—Thus far California has relied chiefly upon European beet seed. Recently a company in Idaho has brought into practice the exact methods of testing and selecting the "mother beets" for seed production which are practiced in France and Germany. By this means the sugar-contents have been increased and shape, thrift and other characters of the beet have been advanced. It is probable that California will in due time develop local seed supplies of the highest quality, but efforts in that direction in this state have not yet succeeded in reaching considerable production.

Of the varieties chiefly used at the present time by the California sugar factories the best information is to be had from the managers who furnish to growers the seed which in their experience yields the best results, and their contracts are conditioned upon the use of the seed they furnish.

BEETS AS FOOD FOR STOCK.

All that has been said about the fitness of California soils and climates to the growth of the sugar beet is also applicable to the growth of beets for stock food. Early plantings of beets furnish succulent food when the pastures yield but "dry feed," which is the local name for grasses and clovers which make rich hay as they stand in the field. Though this food is very nutritious, it is better fitted for fattening purposes than for maintaining the milk-flow, and for this reason it should be supplemented by succulent food. By later planting of beets good supplies can also be provided for the deficiency of pasture growth which occurs when the winter happens to be colder or drier than usual. Thus, by planting from February until June, or even later on moist bottom or irrigated land, the stock feeder can have beets for his animals the year round.

Stock beets are also useful as a succulent food for poultry. By sowing in April or earlier, if local soil conditions admit, well-grown beets can be had for the fowls by August, when it is well-nigh impossible for them to find any wild verdure. They will help themselves to the roots just as they come from the field.

Preparation of the land is the same for stock beets as for sugar beets. The plants must have wider spacing, both for the rows and for individual plants, according to the size of the variety grown. The long red mangel-wurzel, which frequently reaches a weight of seventy pounds, and should average half that or more, needs room. Three feet between the rows and two feet between the plants in the row is as little space as should be given.

Growers of stock beets often sprout the seed before planting, and sow by hand, from five to eight pounds per acre, in a shallow furrow, following a line set by a "marker," and cover with a cultivator or harrow, finally smoothing with a plank clod-crusher or "rubber."

Summer cultivation determines the character of the crop as it does with sugar beets, and the best cultivators secure almost incredible weights of beets from rich, moist soils. The crop often reaches twice that of sugar beets, and though the stock beets are inferior in nutritive contents, the greater crop and the greater ease with which large beets, growing a good part of their bulk aboveground, are gathered and handled are held to compensate for their less nutritive substance.

Varieties.—Of the many cattle beets of Europe three have gained wide popularity in California: the Long Red Mangel, the Yellow Globe Mangel, and the Golden Tankard.

Long Red Mangel.—This variety is the largest and produces the heaviest crops, and is the best generally preferred by dairymen and for hog feed, but requires a deep, strong soil to do well. A rich, sandy loam, a heavy black adobe or a yellow clay, will produce great crops of Long Red Mangels.

Yellow Globe Mangel.—This is medium in size, rutabaga shaped, more solid and less watery, and is the best beet for a light, shallow soil. All root crops, as stated already, require a deep, moist soil, and the richer the better. But Yellow Globe Mangels are recommended on a light or gravelly soil, but in such case a liberal use should be made of old and well-rotted barn-yard manure, well worked into the soil.

Yellow Tankard Mangel.—This is also called "Golden Tankard." It is one of the most famous English varieties. It is very neat and symmetrical in form—cylindrical, narrowing abruptly at both ends. It has yellow flesh throughout. It reaches large size, but can be grown more thickly than the Long Red.

These Yellow Mangels have gained rapidly in popularity during the last few years: first in southern California and now in the north as well. They are better suited for calcareous soils, which are very prevalent in California, and they endure drought better than the Long Red.

CHAPTER XVI.

THE CABBAGE FAMILY.

COMMON CABBAGE.—*Brassica oleracea capitata.*

French, chou cabus, chou pommé; German, kopfkohl, kraut; Dutch, slutkool; Danish, hoved kaal; Italian, cavolo cappuccio; Spanish, col repollo; Portuguese, couve repolho.

SAVOY CABBAGE.—*Brassica oleracea bullata.*

French, chou de Milan; German, Savoyerkohl; Dutch, savooikool; Italian, cavolo de Milano; Spanish, col de Milan; Portuguese, saboia.

BRUSSELS SPROUTS.—*Idem.*

French, chou de Bruxelles; German, Brüsseler sprossen-wirsing; Dutch, spruitkool; Danish, rosenkaal; Italian, cavolo a germoglio.

CAULIFLOWER.—*Brassica oleracea botrytis.*

French, chou-fleur; German, blumenkohl; Dutch, blœmkool; Italian, cavolflore; Spanish, coliflor; Portuguese, couve-flor.

BROCCOLI.—*Idem.*

French, choux brocolis, chou-fleur d'hiver; German, spargelkohl; Danish, asparges kaal; Italian, cavol broccolo; Spanish, broculi.

BORECOLE OR KALE.—*Brassica oleracea acephala.*

French, choux verts; German, winterkohl; Dutch, boerenkool; Italian, cavolo verde; Spanish, coles sin cogollo.

COLLARDS.—*Idem.*

Jersey Kale; Thousand Headed Cabbage or Oregon Kale; also Marrow Kale (chou mœllier)—grown for livestock and poultry.

Other species of *brassica,* grown for fleshy stems or roots, rather than for esculent foliage, will be classed as "turnips" in a subsequent chapter.

California has a vast capacity as a supply region for esculents of the cabbage family. The climate favors production and shipment at a time when the eastern markets have only stored cabbage, and California cauliflower is harvested in splendid size and quality all through the winter months, so that the crop is disposed of before the eastern grower can trust his small plants to the open air. Some years when there have been low freight rates, or a partial failure in eastern production, there have been very large shipments in direct competition with the eastern grown cabbage, in the early autumn, and money has been made in selling California cabbage, not as an early vegetable, but at prices which sauerkraut factories were willing to pay. The eastern production has, however, been more intelligently carried on during recent years, and California producers have less opportunity in the farther east. In the great central region of the country, however, California vegetable shippers find a large market, and growing is done on a considerable scale, but the aggregate is only a small fraction of what the state could easily produce.

The largest cabbage producing regions are the sandy loam uplands bordering San Francisco on the south, the lowlands of Santa

Clara county, the reclaimed islands of the Sacramento and San Joaquin rivers, and the valleys of southern California, both on the coast and in the interior. The last named are the largest producing districts for overland shipment, although the central parts of the state often export largely. Southern California ships usually about 1500 carloads of cabbage, chiefly from March to June, and 1000 carloads of cauliflower, chiefly from November to April.

Cabbage is produced both in large areas wholly given to the plant and by planting between young fruit trees, both in rainfall and irrigated districts. As the cabbage is very largely a winter crop in California, the water which it requires comes free from the clouds or at low rates from the irrigating ditches. The chief objection to the crop is the great fluctuation in value from year to year. It is hardly worth while at $15 per ton, and very profitable at $30 to $40 per ton, and the planting is large or small, according to the preceding year's experience in selling, and this, of course, largely influences the price of the new crop. An average crop of cabbage would be, perhaps, four tons to the acre and the average value $20 per ton or $80 gross value per acre. The cost at current rates for labor would be about $30 per acre.

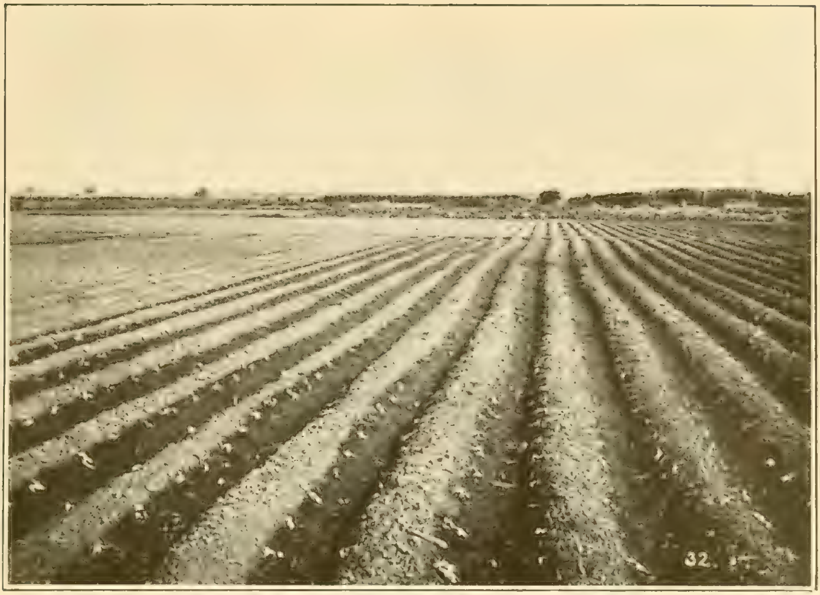
The cabbage crop is chiefly grown for winter and spring gathering. Interior southern situations produce heads ready for shipping as early as February, and the shipment continues, including the later coast regions in southern and central California, until April or later. Thus California is able to reach the markets at the East when the storage houses of eastern regions are emptied of cabbage and the sauerkraut barrels run low and to receive whatever high prices may be available at that time of the year.

California cauliflower is chiefly shipped to distant markets from November to February—the length of the season being determined by the character of the rainy season, which if very wet may put the late crop out of shipping condition; also by the supplies available from Florida, etc.

Although the state is so well suited to produce all the plants of the cabbage family, the common cabbage is the only one which is widely grown by small growers for home supplies. It is the hardiest of the group under neglect or drought, it is true, but there is not so much difference as some imagine. The cauliflower has, for instance, the reputation of being hard to grow, but there is really no difficulty about it if proper effort is made, as will be described later.

THE CABBAGE.

The cabbage can be grown everywhere in California by selecting that season of the year which furnishes the adequate moisture and moderate temperature which best suits its nature. These requirements adapt it well to winter growth generally in California except in the frostiest places, and give the plant a longer season and a greater attainment in weight in regions of rich soils open to



Univ. of Cal. Experiment Station

Lettuce plants set at edge of moisture after running-in water; also fully headed lettuce right to gather.—Page 203.

Photo Sacramento Co. Supervisors

Fruiting of cantaloups in a California garden on moist land.—Page 207.

coast influences. It does not resent fogs and cold winds, and thrives directly upon the coast as well as in coast valleys. In the interior it reaches its best estate on bottom lands, but will succeed on plains and uplands with enough moisture by irrigation to supplement the rainfall, but without irrigation it is often disappointing even though it be started early enough. Cabbage is sometimes a very profitable winter crop in young orchards in southern California.

Soil.—The cabbage does well on heavy soil, and it does not object to alkali—if it is not too strong. It delights in copious treatment with stable manures. For quick fall growth, for early winter maturity, such soil, if moist enough by rainfall or irrigation, will bring it along rapidly while the autumn heat is ample. For later fall planting to reach early spring maturity, a warmer, lighter, well-drained soil or a raised bed will push full growth in a month or six weeks less time than heavy soil in a rainy region, which is likely to be cold and water-soaked. But the cabbage sometimes repays great kindness by growth to bursting or cracking of the head. Care should be had against overgrowth for this reason. Cracking can be prevented by giving heads which threaten it a pull, or a cut through the roots with a spade, so as to lessen its riotous living by partial arrest of its supplies.

Aside from consideration of rapid development, however, it should be said that the cabbage will stand a good deal of winter water and will even go through a period of saturated soil and standing water, making good heads when better growing conditions follow.

The Time to Plant.—These points on soil conditions also suggest different times of planting in different localities, according to what may be reasonably anticipated in the way of heat and moisture. Even in the same locality there will also be different dates of suitability, according to the character of the current season. The best practice is to have plants available in different seed beds and to plant out in succession the thriftiest plants at hand at such times as the season may show fitness. Planting by the calendar is not usually intelligent practice in California, as has been aleady stated.

Growing Plants.—It is wise in most parts of California to start plants in a seed-bed from August to October, irrigating the ground well to guard against drying out on land not naturally moist. In the warmer coast regions good plants can be grown at this time of the year in the open ground. Field growth of cabbage plants with irrigation in southern California is described in this way:

> The land is furrowed out at various widths, depending on whether the wheel hoe or horse cultivator is used in the after-cultivating, and after the furrows have been made a light planker is drawn across the field lengthwise over the ridges, which makes a fine uniform surface on which to sow the seed. This is done with a seed drill, and a row is made on each side of the ridge, thus making a double row with a furrow on each side for irrigation. Unless the land is very moist when the seed is sown, water is turned into the furrows at once and the moisture rises by capillarity to the top of the ridge, thus giving

the seed a chance to germinate at once. As with lettuce, if the seed is too thickly sown it is thinned out so that the plants will grow stocky. As soon as the plants are large enough they are transplanted into the open field, which has been prepared as for the seed rows, except that the rows are always wide enough for horse cultivation and only one row is set on the edge of the furrow.

In the interior, where temperature extremes are liable to be greater, a cold frame, or covered seed-bed, may be used to protect the young plants against hot, dry winds. In small garden practice the use of a seed-box is often handier. Plants should be given space enough to grow thriftily and should be transplanted to the field when conditions are right for planting out in the locality.

Plants started in August and September may be planted in the field as soon as they are strong enough, when an early winter crop is expected, for they will be headed up well from January to March. Where this is not favored by the local climate, it is still advisable to have early grown plants, and in garden practice they can be several times transplanted and thus kept small and stocky for planting out when the soil and weather are right for it. Where the early winter is apt to have quite severe frosts, plants started in the fall in the open air can be transplanted to cold frames until this danger is past.

For late winter and spring planting, plants may be started later, say in January, but then in some places the hot-bed, or other form of gentle bottom heat described in the chapter on propagation, is desirable. Care must, however, always be taken not to use too high heat with cabbage plants, and for usual California conditions a seed-bed, with the soil made light enough for good drainage, and with protection from cold winds as afforded by a fence or building, is usually coddling enough for cabbages. If, however, the plants are grown with heat they should be first transplanted to a cold frame, or a protected bed, for hardening before they are taken to open ground.

Preparation of Cabbage Ground.—Aside from generous manuring; for it is hard to make ground too rich for the cabbage, a good, deep working of the soil will show itself in the crop. For fall planting it is not desirable to give the surface as fine a polish as is necessary for seed sowing, because it will be all the more liable to puddle and crust with the rains. If the plant is well firmed in fine soil, it will take hold well and the interspaces will be more receptive if left a little open. Subsequent cultivation will fine it sufficiently.

In special fertilizing for cabbage in addition to free use of farm manure, worn soils can be enriched with 400 to 500 lbs. of superphosphate and 200 lbs. of kainit, harrowed in before planting, and from 200 to 400 lbs. nitrate of soda is given divided into two to three applications, according to quantity allowed. If as much as 4 cwt. of nitrate of soda is given to the acre, the first portion may be applied when it is noticed the plants are beginnning to catch on, the next a month after, and the last dressing three weeks later. This usually produces a marked effect on the crops.

Planting Out.—Cabbages are usually grown in the field in rows two and a half to three feet apart; laid out with a marker, the plants being distanced about fifteen inches in the rows. Planting is done with a dibble, and a man can plant out four to eight thousand a day, according to his expertness, if he has a boy to drop plants for him. The earth should be pressed firmly about the roots with the dibble.

Planting with a trowel can be very rapidly done in this way. Get a new mason's trowel about six inches wide and twelve inches long coming to a point. Cut off one or two inches of the point, making it round on the grindstone. Put the trowel down in the soil the whole length, pull it over toward you, put in the plant, take out the trowel, then step on the soil near the plant to make it firm.

If the seed-bed is sandy enough and is allowed to become a little dry, the plants can be lifted readily without losing roots. Large bunches of plants when taken to the field should be protected from sun and wind by a wet sack, and dropping should not go far ahead of the planting.

Early planting in anticipation of rains may be surer to hold on if a little water is used in planting if the ground is inclined to be dry. On irrigated ground, which is given a good soaking before plowing for fall planting, this may not be necessary, but subsequent irrigation must be given in time if rains are delayed, for the plants must not be allowed to stop growing.

Planting out on irrigated ground after the land has been prepared as just described for field growing of plants, can be done in this way:

> Have plants of good size and two men to the row; one with a long-handled spade to open a place along the edge of the furrow by inserting the spade at an angle of about 45 degrees and without withdrawing it, but simply raising it up until the other man, who carried the plants in a pail which had a little water in the bottom, could slip a plant under the spade, when by a deft, quick movement the spade could be withdrawn and the soil allowed to fall upon the roots, when the man with the spade was careful to step on the plant just over the roots and thus firm the earth. By having the proper force of men employed to get the plants from the seed bed to the field, so that the men planting could proceed without hindrance, it is astonishing how rapidly the plants can be set; and by choosing the after part of the day and turning the water in right after each row was planted, the plants receive scarcely any check by removal.

Fall planting for irrigation is described by D. F. Reichard in the California Cultivator as follows:

> The main plantings of cabbage and cauliflower seed should be made during September, starting the plants in beds or in rows where they can get the best care. When the plants are six to eight weeks old set out where they are to mature. Prepare the ground by working it not less than a foot deep, having it thoroughly soaked beforehand. After the land is pulverized and leveled, furrow out, for cabbage, eight inches and for cauliflower ten to twelve inches deep, setting the plants on one side of the furrow near the bottom. Then run water down the furrow as soon as the row is set, allowing the water to come up to the plant and as the plants grow gradually work the soil into the furrows until they become ridges.

Field planting by machinery as practiced to some extent in the eastern states, is not prevalent in California.

Cultivation.—Cabbages must be kept well cultivated to reach their best estate. Early cabbages will head in two and a half to four months, according to weather and soil conditions, and size will depend much upon cultivation in connection with soil richness and adequate moisture. Hardly any plant delights more in soil stirring. Rapid growth during the winter also gives the plant the advantage over the lice or aphis, which sap the life of unthrifty plants, and is worse on late-planted cabbages because of the dry, hot weather they are likely to encounter.

Cabbage Worm and Louse.—These two pests are the bane of the cabbage grower. For the cabbage worm take a teaspoonful of Paris green and a pound of bran stirred into a gallon of water and the moist bran is then sprinkled over the cabbages. A cheaper treatment is two pounds of lead arsenate powder (or four pounds of the paste form) to fifty gallons of water—to be sprayed on the plants. To hit the louse also, add four ounces of tobacco extract (40 per cent) for each fifty gallons. The plants ought to be watched and sprayed again later, for both these pests are liable to keep coming. As for poisoning the cabbage with the arsenate, a late government report says that one must eat twenty-eight heads of cabbage at once to get poison enough to make him sick. Still, outer leaves should be removed before cooking. We would not use the tobacco spray on heads nearly ready. A good hard rain or a stiff spray with cold water will dislodge most of the lice if the treatment is given before they become too abundant.

Harvesting.—The cabbage field is usually cut over for a winter shipment three times in about six weeks, and then the ground is cleared up and put in shape for a summer crop.

Cabbage for Stock Feed.—In field growth of cabbage all imperfect heads are used for cow feed and if fed right after milking and not in too large quantities, are said not to taint the milk. They should be fed in connection with some dry feed. Very often cabbage can be grown to advantage especially for cow feed. Planted out in February or March they would be fit to use by the latter part of June, just about the time that the grass gets dry and cows want something juicy to keep up the flow of milk. In their use, however, care must be taken to strip them of any decaying leaves, as nothing will impart a bad taste to milk and butter quicker than the use of decaying vegetable matter of any kind. On moist land late cabbages are considerably grown for poultry and can be pulled for them all through the dry season.

Varieties of the Cabbage.—Of the many varieties of cabbage only a few are largely grown in California.

Early Jersey Wakefield is the earliest cabbage and is widely popular. It makes up in earliness for any lack in size. Heads pyramidal in shape having blunted or rounded peak.

Early Spring: this is the local name of a variety grown by market gardeners around San Francisco instead of Early Jersey Wakefield, as it makes a little larger head.

Early Winningstadt: follows Jersey Wakefield in maturity; pointed shape; head compact, firm and heavy. Very popular in southern California, heading uniformly in the hottest weather.

All-Head Early: the earliest of the large, flat varieties and the largest, uniform growth and good for a long season.

Mammoth Drumhead: head thick and broad, quite flat on top; a standard late variety reaching the largest size.

Cannon Ball: said to be earliest to mature, ten days ahead of Winningstadt; a selection from Danish Ball Head and a better yielder, with a head weighing six or eight pounds; should be planted at fourteen to sixteen inches or the heads may be too large.

Copenhagen Market: good for home garden; fine round head; matures late.

Flat Dutch: very widely grown as a late cabbage; head large, round and solid, flat on top; very sure header and good keeper.

Holland or Danish Ball-Head: very late, not large but very firm and round head, stands in the field a long time; popular for eastern shipment and for winter keeping.

Surehead: large, round, flattened heads of good texture; good for shipping; a long keeper, good for a standard crop.

All Seasons or Succession: a large cabbage, rather late in maturing; has large foliage, which protects the head from the extreme heat of summer.

THE SAVOY CABBAGE.

The distinguishing characteristics of the Savoy varieties is their crimped leaves. They are held to be somewhat milder in flavor than the common cabbage. Their culture is precisely the same as of the common cabbage. They are very little grown in California, but are desirable in giving variety to the home garden supply, and sometimes profitable in local markets. The American Drumhead Savoy is a good variety.

BRUSSELS SPROUTS.

Brussels sprouts require considerably longer to reach maturity than the cabbage, as the little rosettes have to develop at the bases of the leaves after the latter are grown. The sprouts appear first at the lower part of the stem and appear later above, thus giving many cuttings from the same stems. The crown of leaves at the top should not be removed until the stem has done its work. In California the sprouts are taken from the stems in the places where they grow, as our winter does not require taking up the plants and storing them under protection for the winter "sprouting." This, of course, is a great advantage.

The plants are quite hardy and in most parts of California bring their crop in the winter from plants set out in succession during the previous spring and summer. They do best in the cool, summer climate of the coast. Wherever grown they must have abundant moisture all summer. The culture is the same as for cabbage except as to their longer season of growth, which has been noted. The "Improved Half-Dwarf" is the variety mostly grown.

CAULIFLOWER.

The cauliflower is one of the grandest vegetables in California. It attains large size and superb quality, but it is not universally grown, as is the cabbage, because it is rather more tender and exacting and more rebellious under neglect or deprivation. While it is perfectly simple and easy for a person with any joy and zeal in gardening to grow a grand cauliflower, the lack of these qualities will yield distressing failures. He may busy himself with a fair sort of cabbages, but his cauliflowers will point gaunt fingers at him instead of nestling down in tight masses of snowy curds, as if to shame him for his ill-treatment of them. For this reason cabbages are seen everywhere and cauliflowers seldom, except in the market gardens or in the fields where grown for distant shipment—the product being half as large of cauliflower as of cabbage. The largest cauliflower producer of California, J. N. Teague of southern California, grows regularly 160 acres a year and ships over one hundred carloads from his own fields. He arranges to grow early, middle and late varieties and gives the trade almost a continuous supply.

The growth of the cauliflower is in the main the same as the cabbage except that a little higher heat and greater protection are needed for the young plants and a little more diligent cultivation and faithful attention to moisture supply for the later growth. The writer's observation is that most cases of failure with cauliflowers are attributable to delay in starting the plants and planting out too late, and to insufficient or intermittent moisture supply. Summer heading of cauliflower is difficult unless the plants are started in the seed-beds in the winter and planted out early in the spring, for a spring start from the seed is apt to amount to little. Winter heading is surer if the plants are in the seed-beds by June and in ground, properly irrigated and worked, in August. Besides the error of starting at wrong times, many plantings go wrong toward the end of their course, through lack of work and water on the home stretch. In the milder regions it is possible to start so early that less attention, perhaps, has to be given to watering, but where the local climate requires spring planting the reason for failure is generally to be seen in the hard, dry ground on which the plants strive in vain to answer the grower's expectations.

Shipping Requirements.—The following account of selecting cauliflowers for shipment in a San Francisco warehouse gives some good hints of requirements:

With a long knife, he would chop off the leaf ends within about two inches of the head. If he couldn't see the head then without pulling the leaves away it passed as "white and solid" for the incurving leaves have protected it from the sun. If it were too old it would have spread out and opened the leaves apart. But a large percentage could be seen and then a quick look decided whether the head would go into the pile to be sold at about 25 cents per dozen to peddlers for immediate consumption in the city, or whether he would toss it to the representative of the shipping company who was packing the acceptable cauliflower in "pony" crates. Many heads were soft, would spread apart on pressure with the fingers, many were yellowed, many covered with dust blown probably from the road. These could not be shipped.

When to Cut Cauliflower.—According to his own confession, it took R. M. Plympton, of Arroyo Grande, a long time to learn to cut the cauliflower at the right stage. Sometimes it looks all right when still immature. In such cases, a delay of three or four days greatly increases the weight and price without hurting the quality. When such heads are found in the regular semi-weekly picking, the leaves are broken over them so they will not sunburn, or get dirty, or turn yellow, and so the rain will be kept off. Too much rain is likely to hurt the heads. The cauliflower is ready to cut when the sections of a head spread out just enough to show very slightly the lines of separation between them. Plenty of big leaves are left around each head until they are trimmed at the house. If the cauliflower is to go a long distance, more leaves are left on to protect the heads from dirt and injury.

Vegetable crates 20x22x24 inches are packed with about three dozen heads per crate, weighing 110 to 125 pounds—large and small being packed together to economize space. Grading for size is also practiced, however, by some growers.

Soil.—Like the cabbage, the cauliflower likes good, rich soil and plenty of water; coarse, long manure answers the purpose of a fertilizer very well if the soil is heavy; if applied on the surface, either on light or heavy soil, it keeps the ground loose and the water soaks through, and thus the soil is always moist.

Situation.—The cauliflower is less hardy than the cabbage, and where there is a choice of situations in the garden, it should be given, for winter growing, the one which is warmer and more protected. It also resents heat which a cabbage will endure, and for summer growing will be benefited by partial shade.

Growing Plants.—There is a wide difference in practice in different regions. On irrigated ground in the foothills seed is sown in the open ground in June or July, by making the soil as fine as possible; sow the seeds and cover with a slight coat of well-rotted manure; keep well wet down. This prevents drying out and hardening of the ground and the plants come along finely. Similar practice is followed in regions of little frost in other parts of the state at different times from July to September, for winter cutting. As eastern shipments of cauliflower continue from December through the winter, early growth of plants is necessary, and the fall weather is so warm that the seed-bed only needs a little sunshading and ample moisture.

In colder parts of the state, as for example in small valleys liable to sharp frosts, some seasons favor fall-grown plants, others do not, and though it is always advisable to have them for small plantings by those who delight in taking the chances on early things, January or February planting in a hot-bed for spring and summer growth must be the main practice. Hot-bed plants should be grown at rather a low temperature and transplanted to a cold frame or other place under some cover to harden before planting out. Young plants must not be so wet as to "damp-off" and they should not be huddled together as closely as cabbages may be.

After-treatment.—Field growth of cauliflower is like that of cabbage, through for winter growth one must be sure of a little milder exposure. Planting out during the winter must be done with due regard to the fact that the cauliflower is a more tender plant, and extra care must be had to plant when the soil is in proper condition of warmth and moisture. Fall planting requires due moisture and the assurance of it is to push the plant along rapidly.

Garden Practice.—Amateurs who have become discouraged over growing cauliflower are advised to try the method of the late Ira W. Adams, of Potter valley, being sure they are faithful in all points before they conclude that this vegetable must be bought, not grown. Mr. Adams' experience was in a small valley where frosts are rather sharp and where fall planting is seldom satisfactory.

> About the middle of February throw into a snug heap a lot of fresh horse manure mixed with short straw and leaves. After standing a few days to heat, throw it over and let it remain a day or two; then make it into a compact heap (on the south side of the barn), some three or four feet in depth and about twice the surface required for the seed-bed. Tread it down well. On this, place three or four inches of good soil made light and *rich* with fine, well-rotted manure; some leaf mold, sand, and a very little ashes is a very valuable addition. Do not sift the dirt nor have it too fine. This seed-bed must be protected from frost and cold rain, as well as cold days and nights, by a cover of glass or muslin; muslin answers every purpose, is cheaper, easier handled, and does not draw the plants up weak and spindling as glass often does.
>
> From time to time, if the weather continues cold, throw around the seed-bed fresh horse manure sometimes to the depth of four feet or more, leaving only the front side exposed to the sun. The heat generated and escaping from this manure serves to keep the temperature around the bed several degrees higher than it would have otherwise been. When the plants are two or three inches high, transplant to another rich bed without any bottom heat, set the plants three inches apart and keep covered as little as possible in order to harden them. Be *sure* to keep both seed-beds always well moistened (not wet), with lukewarm water. A little weak manure water occasionally is very beneficial.
>
> When the plants are six or seven inches high, transplant to open ground on a cloudy day if possible, or just at night, giving each plant a cup of water. The ground should be prepared in the *best* possible manner and made *very* rich with manure thoroughly decomposed. Horse, cow, hog, and chicken manure mixed as good as any. Put the plants three feet (or nearly so) apart, to give plenty of room for cultivation, which should be done once a

week at least, twice is better, and hoe them often—the more the better, especially early in the morning when the ground is wet with dew. Cauliflower must never stop growing or the ground get dry; they *must have* an abundance of moisture. Run the water down the rows every night if the weather is pretty hot; however, cauliflower succeeds best if fully matured before hot weather sets in, which generally comes early in June.

When they commence to head, gather the leaves together and tie loosely over the heads; this greatly facilitates blanching, and protects them from getting brown and bitter from the effects of the hot sun. They should be examined often and cut while the head is close and compact, as, after the head opens, it separates into branches, gets coarse, rough, fibrous, strong flavored and consequently almost if not wholly worthless.

A cauliflower would be an ungrateful thing if it did not grow with Mr. Adams' treatment. But it will grow and grow immensely. Fortunately, it is not necessary in all places to do quite so much work, or field growth for export would languish. If the reader will discern the conditions which Mr. Adams secures he will be profited, for they underlie the success of the plant in all situations. Breaking the tall leaves so that they will fall inward and protect the forming head is preferred to tying up, by some growers. This should be done as the head begins to form. The cauliflower must be cut for use or sale before the head begins to spread; it must be white and compact or it is worthless.

Inter-Culture with Cauliflower.—Either with cabbage or cauliflower some inter-cropping could be done in the irrigated garden if the fullest use of the space must be made. In early spring planting, lettuce plants grown in a seed-bed can be set between cauliflowers at the same time of setting out the plants. As soon as the lettuce is ready to cut, plant some variety of early beans close to the lettuce, and by the time the lettuce is cut the beans are up, and by this time the cauliflower is ready to cut. Pull the stumps as the cauliflower is cut and this gives the ground to the coming crop of beans. Thus three crops can be raised on the same ground the same season. This cropping can only be done on a summer crop of cauliflower. For winter cauliflower, set Hanson's lettuce between each plant, and in this way have early lettuce when lettuce is scarce. Other combinations and successions will readily suggest themselves.

Varieties of Cauliflower.—Several varieties are popular in this state:

Early Snowball: early and a sure header; large, white, and fine; robust; counted the best all-round variety.

California Wonder: comes into market after the Early Snowball, producing much larger heads, and of the finest quality. It has been extensively grown for eastern market.

California Pearl: held to be specially suited to semi-tropical climates and for shipment because of full leaf-cover of the head.

Dry Weather: claimed particular endurance of heat and drouth; heads large as Snowball and nearly as early.

California Mammoth: of local origin, very large, commended for local use only.

Extra Early Paris: head medium size; compact; stem short; hardy and rather easy to grow.

Extra Early Erfurt: very early, small leaves; solid, fine quality.

Autumn Giant: large, white, firm, and solid; keeps condition well.

Large Algiers: fine for late variety; especially popular in southern California.

Lenormand's Short Stemmed: large, fine, and compact; stocky growth; heads late and protects itself well with foliage.

Nonpareil or Half-Early Paris: midseason variety of good standing.

BROCCOLI.

This is another variety of the same botanical species as the cauliflower. It is hardier and of slower growth, but is smaller in the head than cauliflower and counted less desirable otherwise. It is grown to a very slight extent, and cuts very little figure in California. It is grown in the same ways as the cauliflower but it takes longer to reach maturity. Those who fail with cauliflower might do well with broccoli, which is less exacting.

Mr. Albert F. Etter, of Briceland, Humboldt county, exalts broccoli as not only equal to cauliflower but better adapted to conditions in many places in California. It is slower in heading, but some varieties of broccoli come in near to the late cauliflowers. Broccoli should not be sown too early, nor should it be forced along until the moist air of autumn comes with the rains. Then it will advance splendidly and good full heads can be had from Christmas until February. A temperature as low as 17 degrees will not hurt them much, and not at all if the leaves are tied up over the developing head. Broccoli will make a good fall and winter growth on land which is rather poor, if a moderate amount of manure is spread around the plants at the beginning of the rainy season.

The best varieties are Large or Mammoth White and Purple Cape.

BORECOLE OF KALE.

This term covers the non-heading cabbages, with a wonderful variety and form and foliage, and a record divided between use and ornament. There is a host of varieties, some of which are grown for the tender shoots: others for foliage. The edible sorts are very little grown in California; those used for garnishment are more frequently seen. The two varieties most known are the Tall Green Curled or Scotch and the Dwarf Curled or German Greens. The plants are very hardy and are winter-grown.

TALL GROWING COLLARDS.

The Jersey Kale or Tree Cabbage is quite widely distributed and has won high favor as food for cows and poultry. It is perennial in the coast regions of the central and southern parts of the state, and endures defoliating very well. It is less thrifty in the interior heat and drought.

The Oregon Kale is an old European collard, sometimes called Thousand Headed Cabbage. It belongs to the same class as Jersey Kale, but has thinner stems and is, therefore, more easily handled with mowing or corn-cutting machinery. It was introduced in the Willamette valley, Oregon, more than a third of a century ago, but only recently has its value been recognized as a winter feed for stock and largely grown. It endures local freezing and is hauled from the fields as needed for feeding. The plants are grown in field drills and transplanted in May to the land to be covered with it, the plants being set in every third furrow as the field is plowed and covered in with the next furrow, the ground being afterwards rolled to compact the dirt around the roots. Planting with a machine on land previously plowed and harrowed is also practiced. Kale may also be grown in the way already described for field growth of cabbage except that the plants should be given rather more room. In California the plant is likely to be of value for stock feeding by fall planting and winter growth as well as by summer growth to stand for winter use as in Oregon. In fact, winter growth for summer feeding may also be practicable in California, especially near the coast. As with other members of the cabbage family, dairy cows should be fed kale just after milking to avoid risk of tainting the milk.

Marrow kale or cabbage resembles the foregoing when young, but afterwards the stalk enlarges until several inches in diameter. The pith or marrow often cracks open. It has attracted some attention in the northern coast district for cow feeding.

CHAPTER XVII.

THE CARROT, PARSNIP AND SALSIFY.

CARROT.—*Daucus carota.*

French, carotte; German, möhre, gelbrübe; Dutch, wortel; Italian, carota; Spanish, zanahoria; Portuguese, cenoura.

PARSNIP.—*Pastinaca sativa.*

French, panais; German, pastinake; Dutch, pastinaak; Danish, pastinak; Italian, pastinaca; Spanish, chirivia; Portuguese, pastinaga.

SALSIFY.—*Tragopogong porrifolius.*

French, salsifis; German, haferworzel; Flemish, haverwortel; Danish, havrerod; Italian, barba di becco; Spanish, salsifi blanco; Portuguese, cercifi.

The carrot is a very popular root in California, and is grown in all parts of the state, both for the table and for stock feeding. It is perfectly hardy in all temperatures which come to California valleys and foothills. It is patient during drought and proceeds quickly with its growth with renewed moisture, which is a very valuable characteristic in growing the carrot for stock feeding, but table carrots should not be subjected to this ordeal, but should be pushed with adequate moisture quickly from the seed to size to secure the desired tenderness and mild flavor. To attain the coveted weight for stock feeding, however, it is quite an advantage to have the rain beyond the dry season, as well as before it, because early sowing in cold, wet ground does not suit the plant and late sowing does not give the plant time enough except on irrigated land, to do its best in size before the dry season checks its growth. By proper practice, then, it is possible to produce great crops of carrots in the drier parts of the state, as well as in the moister lands and regions.

Soil and Tillage.—The requirements of the carrot so closely resemble that of the beet that the reader is referred to the suggestions for culture already given for the beet. The carrot has the same liking for a light, warm soil, and the same reasons exist for a deep and thorough preparation of the soil; for, though the carrot, if the seed is sown after the chill and surplus water have gone out of a heavy soil, will do very well if well cultivated, it produces the largest and most shapely roots when it can deeply penetrate and easily displace the soil in its expansion. Carrot ground should, then, receive early working to receive the rains, and be plowed again and well loosened up and fined before the seed is sown.

Sowing Carrot Seed.—It is very necessary that the soil should be in good condition. Sowing in late summer or early fall on moist or irrigated ground is practicable, and so is sowing immediately after the early fall rains have moistened the soil sufficiently to prevent drying out. Plants from October sowing are ready for pulling from March onward, but if the place is quite frosty and the soil apt to be water-soaked, spring planting is better. For this reason, as already stated, some prefer to bridge the dry season, sowing in March or even in April, so that the young plant may have the best conditions at the start. As it gets age it becomes hardier and can be taken from the ground in good condition and maximum size all during the following winter. Late sowing is also advocated because of the opportunity to kill weeds by plowing in the winter growth before seeding. This practice is generally approved in the coast regions of the northern part of the state. On the other hand, in southern California, and in most parts of the San Joaquin and Sacramento valleys, on the lighter soils especially, a start from the seed in December or January, when weather and soil favor it, gives the plant a chance to root well before the dry season and then it is in much better condition to stand heat and drought than if younger. Both practices are rational and each is adapted to its own set of conditions.

Carrot seed must be fresh. It is small, rather difficult to handle evenly, and requires a shallow covering of earth. It is more difficult to get a good stand of carrots than of beets, but care will insure it with good seed. Distribution is facilitated by mixing the seed thoroughly with a certain amount of moist sand, and if the mixture is kept warm and moist the seed may be allowed to sprout slightly before sowing but not too far. The seed must be placed in moist ground, and half an inch is covering enough except in light soils likely to dry down. The seed should be pressed down well or the soil firmed about it, and then lightly covered and the covering pressed slightly.

Cultivation.—Carrots in field culture are usually grown in rows two or three feet apart according to the notion of the grower. Thinning in the row is seldom done though the advantage of it would be shown in better roots just as with beets. Growers shrink, however, from the expense and prefer to trust to frequent cultivation between the rows.

Ridge Culture of Carrots.—Where it is desired to get an early start in a locality with a heavy rainfall the ridge system gives good results. Choose rich soil, plow after the first rain, and then in January or February when the ground gets warm (according to the season and locality) cross-plow and harrow until the ground is thoroughly pulverized. Then ridge some two or three and a half feet apart, rake off the combs of the furrows, making them level on top and free from lumps. Put in the seed by hand or with a seed drill covering lightly, cultivate and thin out for cow-feed during the summer and the crop will be of good uniform size for horse-feed during the following winter and spring. Though this practice is still followed by some it has been widely superseded in field work by later sowing and flat culture. For an early start in the farm garden it has, however, some advantages.

Harvesting.—This is done by pulling, after loosening with the plow. The time, as already stated, is usually during the winter, but feeding often commences in the fall and continues for several months—just as with mangels.

Field Varieties.—Several large, yellow and white varieties are used for stock purposes. The richer color and more convenient size of the yellow varieties hold them in favor as a marketable stock carrot, but the large size and greater crop of the White Belgian makes it a favorite where the crop is to be fed at home. This variety is grown in all California dairy regions. It sometimes reaches a weight of sixteen pounds or more and a yield of over forty tons to the acre on rich, deep land, though half of these figures would better suit average conditions. The Danvers Half Long, in addition to being a good garden carrot, is largely grown for stock. Long Orange is valuable on light soils where digging is easy.

Garden Carrots.—As already stated garden carrots should be grown quickly with acceptable heat and moisture. Simple forcing conditions, like a bed of five or six inches of good loam over a foot or more of tamped manure and a slight protective covering will give very sweet and tender roots to the short varieties in our coldest weather. But so much can be done with the ridge system or with raised beds described in a previous chapter and with other simple modifications of open-air conditions that very little forcing is done.

Country gardeners, as a rule, do not know much about the best table carrots. They supply their tables and their stock too often from the same sowing when much sweeter and tenderer roots should be grown in the garden by small sowings of the improved table varieties. Those which are most grown in California are the following:

Early French forcing carrot: very early, small and fine flavor.

Ox-heart or Guérande: very short, almost cup-shaped, very rapid grower, early and excellent; does better on heavy soils than the longer rooted kinds.

Half Long Danvers: a popular market variety, strong grower and succeeding on a wide range of soils; rich color and good flavor.

Improved Long Orange: smoother and more uniform than the old sort; also better flavor and color.

Chantenay: short and sturdy, bright orange-scarlet, early.

Improved Short White: best of the whites, short and cylindrical.

Red St. Valery: one of the best of the medium long varieties.

Early Scarlet or Short Horn: largely grown and of good quality.

THE PARSNIP.

Parsnips are not largely grown in California. Two considerations may be involved in an explanation of this fact: one is that our winter supply of fresher vegetables relieves us from dependence upon root-boiling, which is the staple resource of so many dwellers in cold climates; another is, that the parsnip, if sown early, is not always content to remain dormant and crisp for months as it does beneath the snow. It quickly responds to our winter warmth and moisture and starts second growth, which renders the root woody and flavorless. It is quite possible for parsnip lovers in warm, moist regions to overcome this by mid-summer sowing or it can be prevented in other places by digging the roots and storing them in boxes or barrels of sand in a dry, cool place, and it really should be urged that this be done more widely, because those who are not fitted by location or inclination to start fall growth of vegetables for winter eating, should have a good supply of parsnips, which are, to most tastes, delicious. It is not to be expected in this climate that the parsnip will be called upon to render the important service that it does in the East whenever the snow uncovers the ground in the winter or spring, because at that very time we have abundance of fresh vegetables hardy in our climate.

Soil and Culture.—The excellence of the parsnip is vested in a well-developed root, and to secure this rich, deep, and permeable soil and adequate moisture are required. Deep cultivation and manuring will secure these qualities even in rather a heavy soil. Parsnip seed is light and should receive a shallow covering but it is necessary that it should be well firmed in moist soil to secure germination. As soon as the plants are two or three inches high the rows should be cleaned of weeds, the plants spaced, and frequent use of the cultivator begun, to continue all summer. The suggestions made for the preparation of soil and cultivation of the beet and the carrot have direct application to the growth of the parsnip, and the reader is referred to them.

In the rainy parts of the state it is customary to sow parsnips as soon as the ground is in good condition in February, as the plant is quite hardy. From this date onward the seed can be successfully sown as long as the soil has moisture enough, and in moist interior lands seed can be sown in July, or even later, and the plants will make a good fall growth and be ready for winter use from the ground, as late sowing in a warm region with moisture assured, carries the plant along without danger of a check and a second growth.

Varieties.—These varieties of parsnips prevail in this state:

Hollow Crown or Student: long, large, smooth roots in deep soils; tender, sweet, and fine flavored when well grown. This is the chiefly grown variety.

Improved Guernsey: half-long, shorter and thicker than the foregoing.

Devonshire: another short variety popular with market gardeners in southern California.

Round or Turnip Rooted: better suited for shallow soils, owing to shape; develops faster than the long type.

SALSIFY.

This delicious root stands subject to the same conditions which have limited the growth of parsnips in this state, but its popularity has increased greatly during the last few years. The requirements of the plant in soil, culture, and season correspond very closely to the parsnip, and it is taken from the ground all through the autumn and winter as parsnips are in California. The seed is a little more difficult to start, and pretty generous seeding in soil sure to retain fair moisture, and a slightly deeper covering than with parsnip seed are desirable. Thinning is essential but the root is slimmer and does not require so much room. One variety prevails in local interest, the Mammoth Sandwich Island. It is large and otherwise better than the older kinds, although the Long White is still grown.

CHAPTER XVIII.

CELERY.

CELERY.—*Apium graveolens.*

French, céleri; German, sellerie; Danish, selleri; Italian, sedano apio; Spanish, apio.

CELERIAC.—*Idem.*

French, céleri-rave; German, knoll-sellerie; Dutch, knoll-selderij; Danish, knold-selleri; Italian, sedano-rapa; Spanish, apio-nabo.

California celery taken from the field during the winter months and delivered in the eastern markets by frost-proof cars has, during the last few years, made decided progress in competition with the eastern product taken from frost-proof storage in pits, or specially-constructed celery houses. On certain well-suited soils in regions subject to coast influences and, therefore, with moderated summer temperature, the celery plant makes a grand summer growth, with or without irrigation, according to the natural moisture of the soil, and encounters no fall or winter temperature which injures it in the open field. In fact, in these special localities and soils, which will be described presently, the plant finds naturally provided those conditions for splendid development which in less favored regions, can only be secured by considerable artifice and investment. For these reasons commercial celery growing for distant markets became a considerable industry, giving great value to lands suited to its uses, and reaching a product valued in 1916 at a million dollars. Annual shipments are about 3000 carloads, of which about three-fourths are produced in the delta region of the Sacramento and San Joaquin rivers and on lowlands near Sacramento, and one-fourth in Los Angeles and Orange counties.

In many parts of the state, especially on low, moist lands which are frequently of saline character, wild celery grows thriftily, and its growth has served as an incentive to commercial planting. This wild celery is, however, not a native plant. It is merely the garden celery which has escaped from cultivation and the escape must have been at an early date, for the occurrence was noted by botanists at least thirty years ago. It is now widely distributed.

Locations for Celery.—Celery thrives best in an equable, cool temperature, but it accepts conditions in the "cool night" districts on the lower lands of the interior valley. It does not well endure high heat; it is hardy against California valley frosts, and it demands adequate moisture. It is, therefore, successfully grown in the fall and winter in regions where summer heat is too high, and in the equable coast climate it can be enjoyed all the year, providing ample soil moisture can be assured. Commercially, it is summer grown for winter shipment because it is then best received in the eastern markets.

Soils.—Aside from abundant moisture the chief requirement of the plant is large amounts of decomposed vegetable matter in the soil. This is provided in ordinary garden soils by the free use of well-rotted manure, mixing it thoroughly with the soil by deep digging in or trenching, and for home supplies this should be undertaken, but those who can, may avail themselves of the conclusions of a grower at Castroville, near the coast in Monterey county, who, after trying for a number of years, almost in vain, to raise good celery on an ordinary dry garden soil, finally borrowed the use of a little patch of reclaimed swamp land—deep, black muck, well drained but moist—and grew on it very fine celery with but little labor. In undertaking production on a commercial scale this advantage of specially suited soil is imperative. An instance of such soil-fitness is found in the peat lands of the river deltas of southern and central California, where celery growing has reached the importance above noted. The soil largely consists of decomposed vegetable matter and becomes, on cultivation, fine and homogeneous. It is different from the partially-decomposed and coarse material of the tule swamps. It occurs in Orange county in deposits of varying thickness and sandwiched with layers of sediment or clay, the peat layers being, however, connected through the dense layers by tubes through which the water rises in springs and sub-irrigates the surface layer. This surface is treacherous. Much of it will only support horses when shod with plank and some cannot be traversed with animals and is worked by drawing tools back and forth with cables from firm headlands on each side. Still it is so productive of celery that such bottomless land has been rented as high as twenty dollars per acre per year.

In addition to the peat lands celery is also successfully grown on light sandy loams and on river sediments. The lightness of the soil is directly involved in the blanching, which will be noted later.

Heavy fertilization is often very desirable for celery, especially on the lands last mentioned. Instances are given in which nitrate of soda was used at the rate of 675 lbs. per acre after the crop was growing on land which has received twenty tons of stable manure and thirty bushels of slacked lime per acre. In this case it is also claimed that the crop was ready five days earlier than that which received no nitrate.

GARDEN CULTURE OF CELERY.

Celery plants are grown in a seed-bed for transplanting to permanent place. The seed is very small and very slow of germination, and success depends upon maintaining even moisture at the surface. For starting plants in winter a hot-bed may be used, but high heat is neither necessary nor desirable. A cold frame with cloth cover would be better. But it is quite feasible in coast valley situations to grow the plants in the open air early enough in the spring to get the crop for the table from November onward. Simple and correct suggestions for garden culture are given by Mr. S. J. Murdock, of Orange county, as follows:

> It requires from three to four months from time of sowing the seed till the plants are large enough to plant out. The warmer the weather the quicker the plants will grow, and the warmer and drier the atmosphere is, the more water the seed-bed will need. Select rich, friable soil and sow the seed evenly and only moderately thick. Cover the seed but lightly, as they are very small, and firm the soil well. Keep the soil or bed moist, not soaking wet, but never dry, and have patience as they are slow to germinate. Keep free from weeds and thin if too thick; one plant to the square inch is about right. When the plants get about three inches high, clip the tops off, not too close, but about half way, and continue to keep the bed moist, and when about four inches high clip again, and they will be ready to plant.
>
> In about a week or ten days after clipping lift the plants with a shovel or garden trowel so as not to disturb the fine roots more than is necessary. Trim the main or taproot to two or three inches and keep the roots moist until planted. Select a good, rich plat where water is handy, as the ground should be as moist as possible to work, and draw shallow furrows, say about four inches below the level, and put the plants six inches apart in the row. I would prefer a single row of sufficient length to two or more shorter ones.
>
> Take a hardwood peg, about one and a quarter inches in diameter and six inches long; sharpen one end to make the holes for the plants. Put the roots straight, and be sure and firm the soil well around each plant.
>
> Stir the ground around the plants and keep the soil away instead of up to them till the plants get twelve or fourteen inches high, then work the soil to the plants (but only when they are dry) and keep the roots moist. If in the interior valleys, it is better to blanch it with boards than by banking with the earth. Blanch by setting twelve-inch boards on edge on each side of the row and secure them with stakes stuck in the ground and tied at the top, or some dirt thrown against the bottom of the boards and the tops held together with notched strips. It requires from two to three weeks to blanch the White Plume and longer for the green sorts. One set of boards will blanch two or three lengths, as they can be moved along the row as the celery is used. Never bank or board it when wet, and be sure to have both bank and boards close enough at the top so that the leaves will shed the rain to the outside.

Blanching may be also done in garden culture by the use of drain tiles or by wrapping the plants in pieces of sacking. Any arrangement which excludes light and water from the stems will accomplish the desired results.

FIELD CULTURE OF CELERY.

Field culure of celery on the very friable peat lands which have been described has developed appliances and processes which are very effective and satisfactory, and cheapen production to an extent not attainable except on very friable soils. Still the practices inculcate the ends to be attained in all cases, though the means may differ. Mr. S. J. Murdock has given a very explicit description of the methods he has found most satisfactory in his experience, from which the following is largely compiled.

The Seed-bed.—A seed-bed which is naturally moist or which can be sub-irrigated is preferable, although the raised bed with irrigation by seepage, or other arrangement for maintaining moisture may be used. The soil must be light and free from baking. The seed-bed should be plowed by the middle of December and left rough for the action of frosts and rains, and about two weeks before sowing, harrow down and thoroughly hand rake. Let it lie till seed-time, which is during March, April and May, as to season or early or late planting. The early-sown seed requires longer time to make plants large enough for planting, but if planted moderately thick and well cared for, makes strong, sturdy plants. Planting earlier than February is, however, undesirable as the plants are apt to go to seed after planting out.

At planting rake the surface thoroughly again with a sharp, close-toothed rake and either drill or sow seed broadcast. The drill is preferable but if broadcast lightly rake the seed in and either roll or firm the soil thoroughly, as there is much seed lost by neglecting this part. The seed-beds are generally made from four to six feet wide, leaving room between each bed to weed and clip them, which constitutes the after care except to keep them moist. Keep as free from weeds as possible, and when the plants get about three inches high, clip the tops about half way down, and when they get three or four inches high, if not ready to plant, clip again, as the keeping of tops back makes the plants better for transplanting.

Irrigation is often used to start the plants strongly at first, but subsequent growth is secured by very sparing use of water if possible. Standing water among the young plants should not be allowed. It is usually counted that one acre of seed-bed will furnish plants for twenty acres of planting out.

Planting in the Feld.—The land should be thoroughly cleaned of trash and given early and thorough preparation as will be described in the chapter on corn. In Orange county planting in the early part of June brings the crop for Thanksgiving and in July for the holidays and later. In the Stockton district experience has favored planting out not later than June in order to bring the crop out of the field before the heavy rains and frosts of the lowlands in the early winter, which have previously occasioned some heavy losses.

Laying off for planting may be done by taking off all but the three inside discs of a disc harrow, attaching a shovel plow in the middle and close behind the harrow, and following this with a five or six-foot roller with a raised belt around the center, which runs in the plow furrow and forms a compact trench about six inches deep. Three and one-half or four feet is the usual distance between the trenches, and the plants are set six inches apart in the bottom of the trench.

A full crew of planters is ten men; one to lay out the furrows, one spacer or marker, who has an implement which makes from four to twelve holes at a time, depending on the size of tool used. There are also four planters and four plant pullers. It is the duty of the first man to draw the furrows as straight and as near equidistant as possible, give general supervision of the planting and see that the pullers use judgment in preparing the plants. Unless the plants have been recently clipped in the bed, both tops and roots need clipping when pulled, so as to leave the main or taproot about two and one-half or three inches long, and the tops clipped of the surplus leaves. They are usually put in large-sized milk cans, the roots kept wet and delivered to the planters in the pans. The spacer makes the holes for the plants just ahead of the planter. Both the furrows and holes for plants should be freshly made so as to have no dry dirt to hinder the planters, who should be careful and painstaking, as the plants need to be put in the proper depth, the roots straight and the soil well firmed around each plant and no unfilled space beneath the plant to dry out. A crew should plant from an acre to an acre and a half per day, according to the condition of the land and the proper oversight of the force. This mode of planting leaves the plants from four to six inches below the general level.

Crowding.—The next operation is called crowding, which is done by a tool made as follows: Take a common iron or steel cultivator, take the standards and shovels all off, then take two pieces of steel one-fourth of an inch thick, six inches wide and four feet long. Sharpen one edge of each piece and bolt to the outside frames of the cultivator so that the tops of the steel bars are about even with the top of the frame and on top of the rear half of each, add eight or ten iches of heavy sheet iron. The front of these blades should be from five to six inches apart and the rear about thirty inches. In a week or ten days after planting, hitch two steady horses to this tool and crowd the dirt away from each side of the rows. This kills the new weeds just starting and covers up all in the middle of the rows and leaves a ridge of loose soil. Follow this by going over each row and filling in all the missing plants with strong vigorous ones and uncover any plants covered by clods or loose dirt; then take a light, narrow hoe and draw between each plant. When plants get larger, work the soil back to them to prevent spreading. Keep well tilled, and soil moist by irrigation if necessary.

Rolling.—The handling of the soil after "crowding" is described by Stanley S. Rogers in this way: The earth between the rows of plants is left in a ridge after the plants have been "crowded." A large wooden roller which extends across several rows is now used to flatten down these ridges and pack to soil more firmly. The roller is used only when the plants are small, otherwise they would be injured by being crushed. When the plants have grown sufficiently to be injured by this rolling of the middles, the ridges are smoothed down by the cultivator.

Splitting.—When the plants are twelve to fifteen inches tall, earth from between the rows is drawn up to them. This is termed "splitting." This should be done carefully, for, if the earth is put too close or too high up on the plants, they will become tender and weak, especially if the weather is hot. The object of "splitting" is to gradually encourage the plants to grow tall and straight instead of spreading out. This operation is repeated twice during the season, the first time when the plants are fourteen to sixteen inches tall and the second time just before banking. This last "splitting" also aids blanching.

Blanching.—There is in market gardens some blanching with boards set on edge on each side of the rows secured by stakes made of lath stuck in the ground and tied together at the top, but in large field growth it is done by banking the soil up to the plants. This is done by a machine made the reverse of the crowder described for first use and much larger and heavier. It is used with wide end forward, which draws and crowds the loose earth up to the plants. Blanching is done when the celery is reaching its maturity and is nearly ready for shipment. This is the last field operation before the crop is cut. When the celery is banked for the first time the earth is not drawn very high on the plants, but each time the field is banked the soil is drawn higher so as to firmly hold the leaves together and in an upright position. If celery that has been banked for the last time is not harvested shortly, it will soon become "punky." The length of time that it can safely be left in the bank depends upon the character of the soil, the weather conditions, and upon the condition of the plants themselves. Celery on sandy soil will keep much longer in the bank than on adobe or peat soil. If the celery has not matured or if the weather is hot or moist its keeping quality will be injured. Holding too long in the bank will result in a wilted and "punky" product.

Harvesting.—Although in small areas the plants are cut-under with long knives, shovels or other hand tools, on large fields the harvesting is done with a "U" shaped cutter attached to an old sulky plow frame, which straddles the rows of banked celery, cutting off the roots and raising the plants in the loose soil. This is followed by the trimmers, who lift the plants, trim off the outer stalks and square the roots. It is now ready to tie in bunches or crate.

Marketing.—Celery is shipped in crates, 22x25 in. base, which holds six to eight dozen of celery, according to size. An average crate will weigh about 145 pounds, and 160 crates make an average carload. Some eastern dealers prefer the celery shipped in bulk or on decks built in the car. This is a much cheaper way to ship, and is claimed by some to be just as safe. In shipping in this way, three decks are built in the car, and the celery is tied in bunches of one dozen each and stood upright with roots resting on the decks. By this method three or four hundred dozen more celery can be packed in a car. Celery is shipped to all the principal cities of the United States and Canada, and carries successfully.

The Yield.—An estimated yield per acre is about 1200 dozen bunches, which may be worth $300 gross. The average cost of growing the crop is placed at from $60 to $100 per acre.

Varieties.—Formerly the White Plume was the chief variety grown for shipment, but it is now chiefly used where an early crop is particularly desired. The Golden Self-blanching is now chiefly grown, especially for eastern shipment and California seedsmen offer improved strains Green Top. It will be well for home growers to try also some of the higher quality varieties offered by the seedsmen when they are ready to take particular pains to grow them well. Such varieties are Columbia, White Globe, Giant Pascal and Winter Queen. These varieties are popular with market gardeners.

Celery Blight.—Occasionally atmospheric conditions favor the growth of a leaf fungus known as celery blight, and great losses have resulted in some years. Recent experience shows that the blight is subject to control by spraying the plants with the Bordeaux mixture, as described in Chapter XXXVIII, as soon as signs of the incroachment of the disease appear, or when weather conditions indicate the danger to be imminent. Special publications on this subject can be had from the University Experiment Station at Berkeley.

CELERIAC.

The turnip-rooted celery is very desirable for cooking and salad purposes. It is grown in nearly the same way as ordinary celery except that it is allowed to make free top growth without blanching, as the root is the edible part. The Large or Giant Smooth Prague is the variety chiefly grown.

CHAPTER XIX.

CHICORY AND ENDIVE.

LARGE ROOTED CHICORY.—*Cichorium intybus.*

French, chicorée sauvage; German, cichorie; Danish, sichorie; Italian, cicoria; Spanish, achicoria; Portuguese, chicoria.

THE ENDIVE.—*Chicoria endivia.*

French, chicoree endive; German, endivien; Dutch, andijvie; Danish, endivien; Italian, indivia; Spanish, endivia.

The chicory plant cuts no figure at present in the general gardening of Californians. The use of the blanched leaves, forced in the dark from mature roots bedded in sand, is confined to a few foreigners who know the *barbe-de-capucin* of the French or the *witloof* of the Germans. It is a delicious vegetable, either raw, boiled, or as a salad. Nor are the leaves in their natural state much used here for salad. Both of these uses of the plant should be more widely known in California, for the cultivated growth of the roots in this state is very fine, and for running wild, as an escape from flower garden culture, it might be denounced as a vile weed were not its large blue flowers so beautiful upon the yellow of our dry summer fields and roadsides.

Viewing the plant as yielding a root rather than a foliage crop, it has been of much importance in this state. The root, sliced, dried, roasted and coarsely ground, is the "chicory" of commerce—the adulterant of coffee which nearly every one denounces in theory and many enjoy in practice; for the occurrence of absolutely pure coffee is so restricted that it often, at first, offends the palate of the unaccustomed drinker. California chicory growers for years contested the American markets with German chicory, and a very capacious factory was in operation near Stockton for more than twenty-five years, and at one time there was another near Sacramento. The vicissitudes of tariff legislation have made the business uncertain, sometimes very profitable, sometimes not, according as the German product entered free or paid duty. If the tariff would maintain a favorable attitude, California could furnish cheap coffee for the whole country and beet-sugar for its sweetening besides. For the last few years, however, the business has been much reduced and depressed. For the home-grower of coffee counterfeits, the chicory plant offers a better material than the "coffee bean" and other substitutes which are offered, but all substitutes have had a hard road under the pure food laws. The growth of the plant and its preparation for the breakfast table are quite simple.

Chicory grows to prefection on light sedimentary soils which afford the root opportunity for expansion, and retain moisture enough for its thrift during the long, dry summer. The plant is hardy and the seed is usually sown in February. The preparation of the soil, sowing, thinning, weeding and cultivation, are identical with the same operations for the sugar beet already described. The expense with chicory is, at present at least, considerably greater than with the beets, because the moist land which is used gives more persistent weed growth and occasions an amount of hard work which is appalling to an observer. The crop partly compensates for this outlay, because the value per ton is twice as great as the sugar beet, and the crop is not enough less in weight to equalize things. The average crop on Roberts island near Stockton in favorable years is about ten tons to the acre, though some years the average will go to twelve and the best crops to fifteen tons per acre. The factory price for the fresh root has usually been $10 per ton. The cost of growing, including rent, ranges from $50 to $80 per acre. The soil on Roberts island is a mixture of sediment and peat—deep, rich, light and moist; most admirably adapted to the root.

Harvesting and Curing.—From seed sown in February, harvesting continues from the middle of August to the middle of October. Early gathering is necessary, as sun-dried chicory is better than that cured by artificial heat. When ready for gathering a plow is run along each side of the plants with subsoil cutter and lifter attached, which loosens the roots so that they can be easily lifted from the soil by the hand clean and ready for the cutting machine. This operation is like the gathering of sugar beets, and the topping or removal of the leaves is the same.

When they reach the factory the roots are placed in the machine, which cuts them into cubic blocks three-fourths of an inch in size. The drying platform comes in use next, and when the chicory has been dried as far as sun power will dry it, it is placed in the roasters, each holding two barrels, where it is roasted as coffee is before being ground. From the roasters it goes to the mill, where it is ground, put in barrels, and thus becomes the chicory of commerce.

The preparation of chicory for home use is a very simple operation and can be done with ordinary kitchen appliances.

The variety grown is the "large-rooted Magdeburg," with leaves entire and upright.

THE ENDIVE.

Though botanically a chicory, the endive in its uses is closely allied with lettuce and is chiefly useful during the frosty period of the year, for then its flavor is likely to be better than that of lettuce, because it is able to grow more rapidly with low temperatures. As, however, there is so much of California which does favor rapid winter growth of lettuce the use of endive is correspondingly restricted. Still in localities with heavy rainfall and long stretches of chilly winter weather, the endive will give good supplies of salad material and should be better known. It is also valuable as a boiled vegetable possessing a distinctive flavor which is generally acceptable, and used in this latter form it is quite a valuable addition to such plants as Swiss Chard and Spinach.

As a salad plant the value of endive depends largely upon its being properly grown and thoroughly well blanched. Blanching induces delicacy and tenderness of eating and can probably be best effected by bunching up the leaves and tying with string or raffia, or by spreading hay or straw thickly over the plants. Some care must be given to the proper blanching of the plants, for unless this is successfully accomplished endive is not likely to be appreciated. Small quantities of blanched endives are brought to San Francisco by express from New York, where its importation from Belgium and France is regularly made. It comes in 20 lb. baskets and is sold in San Francisco at 50 to 75 cents per pound. European gardeners coming to California have tried to displace this importation with a product locally grown in European ways but have not found the undertaking profitable.

The plant is easy of culture, the methods being essentially those described for lettuce, but chiefly sown in summer and early fall for use in the rainy season. The following varieties most largely use in California:

Green curled: very curly, midrib whitish, leaves finely divided.

White curled: yellowish green, very curly and attractive looking.

Escarole or Batavian: leaves wider and thicker, dull green, a good variety for boiling.

Staghorn: strong-growing, leaves curly but less finely divided and thicker, also good for cooking.

CHAPTER XX.

CORN.

SWEET CORN.—*Zea mays.*

French, mais sucré; German, mais; Dutch, Turksche tarwe; Italian, grano turco; Spanish, maiz; Portuguese, milho.

California cannot claim to be a large producer of corn, though it does grow large corn and has a long green corn season. Of the summer grains corn is produced in least amount, because the others can make winter growth and corn cannot, and they mature at about the time when corn can be safely planted. They pass the dry season in the sack while corn has to endure it in the field and does not take kindly to it. Dry heat puts it in distress which irrigation does not wholly relieve. In the place of corn on the interior plains improved varieties of sorghum are now largely grown both for the grain and the forage.

But while this is true there are regions in which magnificent corn is grown. These are usually moist lowlands from the valleys north of the bay of San Francisco southward to San Diego; near enough to the coast to catch something of atmospheric humidity from the ocean, and still with summer heat enough to suit this warmth-loving plant. There are also great corn lands in the river bottom of the interior valley, where the drought is less than on the plains, and in the low moist lands of the foothill and mountain valleys as well. In all these places and where similar conditions are produced by irrigation, corn reaches great dimensions.

Of course corn as a vegetable is somewhat different from corn as a grain. So also is corn as a green forage plant. For "roasting ears," and for green forage, ripening conditions are not essential, and for these purposes the plant can be carried nearer to the coast than for a grain crop, and in the warmer regions it can be planted late for a longer succession than for grain if moisture enough is provided. It is not uncommon, therefore, in the interior to have good roasting ears at Thanksgiving or even in December at elevations or in other places where early frosts are seldom known. Thus corn as a vegetable is California is a greater affair than corn as a grain. It would have even a greater value as a garden plant were it not for the ravages of the ear-worm, which takes its full share of almost every ear at the times when its appetite is good.

The Corn Ear-Worm.—The ear-worm is the larva of a grayish or brownish moth about an inch long (*Chloridea obsoleta*) and is the same insect as the cotton boll-worm. If the ears get into condition to receive the eggs when the moth is ready to lay them, there is thorough infestation. Sometimes the ears get too far advanced and early sown corn largely escapes that year, and sometimes the ears come between broods of the moth and, in that case, they are relatively free from injury. With garden corn, in a place with a long frost-free season, the suggestion is to plant corn at intervals in the hope that some of the plantings may shoot ears at wrong times for the moth. Generally the late planted corn escapes, or is more apt to escape than the early planted, but sometimes, in some places, the opposite is true.

When sweet corn begins to silk, C. E. Trapp, of Los Angeles, irrigates thoroughly and keeps the ground moist till all the corn is picked. This fills out the kernels and rushes the corn so fast that the majority of worms which hatch in the silks, will not have time to work their way far down the ear. He has observed that drier corn in fields near by is badly spoiled by worms. Robert Haenggi encourages the blackbirds which he has observed dilligently seeking the worms. They stand on the ear, seeming to listen, and then open the husk directly over the worm. Blackbirds are also to be credited with saving much field corn from the corn worms.

Some growers choose flint varieties of field corn on the belief that the flint hardens earlier in summer and prevents the worms going down so far on the ear.

In 1915 M. L. Germain, of Los Angeles, dusted the silk of the ears as soon as it appeared with arsenate of lead powder. The corn which he treated was fully 90 per cent clean and free from worms, while that portion which was not treated was fully 95 per cent wormy.

Soil.—The requirements of Indian corn are so widely known that it will hardly be necessary to enter minutely into them. The soil should be preferably a rich loam, sufficiently retentive of moisture and yet easy to keep in fine tilth. Satisfactory results can, however, be secured on quite a variety of soils if warmth and moisture can be assured. In the heavier soils there is much advantage in plowing under the disintegrated roots of previous growths of weeds or crop-plants and the best corn often comes here as elsewhere on newly-broken land.

Preparation for Corn.—As the corn plant resents drought so strenuously it is very important that preparation of the land should include efforts for thorough moistening of the land by rainfall or irrigation, followed by surface treatment to prevent evaporation. All that has been urged in these directions in the chapter on cultivation has especial pertinence in preparation for the corn crop. It is vain to expect to succeed by shallow cultivation except where the land is naturally sub-irrigated, and even on such land there must be deep working enough to place the seed below the dry surface layer. Slack preparation on lands which naturally dry out in the summer assures failure and disappointment.

Planting.—Corn is a very tender plant and must be planted not only after frosts are over, but after the soil has become well warmed and warmth may be expected to continue. The date of planting must be determined by the local attainment of these conditions. From this time onward through the summer, planting may be done if moisture enough can be retained in the soil. For this reason, on moist or irrigated land, corn is planted after winter-growing crops are cleared away, and large yields are secured. Near the coast where the corn plant is constantly refreshed by ocean moisture in the air, it will make good green growth with what remains from winter rainfall on land from which a crop of beets or carrots, sown the previous season, has been cleared away. In such rotation the land should be plowed as early as possible after the roots have been taken off, to keep down the growth of grass and weeds and retain moisture till the proper time for planting corn, which will depend a good deal on the wetness or dryness of the season. The earliness of the first planting will depend mainly on the fitness of the land and the situation, but for early use, some early variety of sweet corn should be planted as soon as circumstances are favorable for doing so, to be followed by several successive plantings, say through May and June, and even into July. In suitable situations in southern California sweet corn is planted through eight months of the year; as early as February 1 in the Coachella valley and as late as September near the coast, where roasting ears are expected in about seventy days from planting on irrigated land.

Hill or Rows.—Growers differ as to the advantages of growing in hills or in rows. Hills give opportunity to cultivate in two directions with the horse. Rows have a tendency to check the draft of dry winds when the rows run at right angles to their anticipated direction. The general course of dry, hot summer winds is from north to south (except where given a different trend by local topography), consequently east and west rows oppose them and in some measure shade the soil and the plant better from sun heat. But when prevailing practice shows that the ground in the row usually goes untouched by tools and consequently becomes hard and dry, it is quite a question whether the separation of the plants into hills for free cultivation both ways is not on the whole much the better method. But choice may be governed by local conditions. Planting in hills at 3½ feet square takes about nine pounds of seed to the acre.

Laying Off and Planting.—Distance in corn planting depends upon the habit of growth of the variety. Small early kinds may be planted in hills three feet apart each way or in rows three feet apart, but larger kinds may need wider spacing, even up to five feet. Seed should always be planted in excess: five or six kernels to the hill, to be thinned to the three or four strongest plants; four inches apart in the row, to be thinned to ten or fifteen inches according to size of variety.

For laying off hills in straight lines after plowing and harrowing, a marker should be used both ways and the corn planted at the intersections of the lines either with the hoe or the hand corn planter. For planting in rows the drill attachment or hand dropping in the furrow is used, followed by the harrow.

Depth of planting depends upon the soil and the situation for the reasons given in the chapter on propagation. On very light soils in dry regions very deep covering is admissible because the few inches at the surface count for nothing, but on heavier soils in good moisture, and especially early in the season, shallow covering is preferable.

For succession there should be planting done in the garden every two weeks during the local season.

Selection of Seed Corn.—W. D. Trewhitt, of Kings county, gives seed selection much credit for his high acreage yield. Two selections are made each year. While the corn is still in the field it is gone over the first time, stakes being stuck in the ground near those stalks which are medium in size and which carry a medium amount of long, straight row ears. At harvesting time the ears from these stalks are husked separately and taken to the barn where they are later picked over again. Here the ears are compared again, the above qualities as well as the tightness of the grain on the ear being considered. The ears scoring the highest in this final selection are the ones used for the next year's seeding, the butt ends, however, never being used for seed.

In 1912 W. G. Stimmel, then superintendent of the Stanford ranch at Vina, began selection from the growth of eastern seed secured an improved type which is called "Stanford Yellow Dent" and has gained wide approval.

Cultivation.—If deep working of the soil is the foundation of a corn crop as stated, frequent summer cultivation is the building itself. If the ground is well laid off, the cultivator can be used to advantage, even before the corn shows up to destroy weeds and loosen the surface. Afterward the cultivator should be run at very short intervals, for the hot, dry season is always right at the heels of the corn planter and should never be allowed to catch up with it. Some of the finest corn we ever saw was grown in Orange county in this way: The land was plowed four times, irrigated twice, hoed twice, and cultivated and worked in a most thorough manner. In the whole process of raising the corn the grower went over the land no less than sixteen times. It is hardly to be expected that such diligence will be general, but it has to be recognized as the price of the best results.

Combinations with Corn.—As a tall, upright plant corn is available for sticking in with other vegetables of spreading habit and in hot regions may be used to give partial shade to other plants which do not enjoy summer heat as much. In the field planting of squashes, cow peas and other running plants is available here as elsewhere, if there is soil moisture enough. In the garden a wider range is available.

Corn and tomatoes are planted half way up on the sides of furrows in Manuel Veter's garden in Tehama county. When water runs through the furrows it soaks the roots without touching the plants. Part of the ridge can be raked into the furrow so soon as the water has sunk away. This will kill weeds and prevent the evaporation and baking, but keep the roots moist.

In July while the sweet corn was in silk F. Guido, of San Mateo, set large cauliflower plants about 18 inches apart half way up the ridge along each row of corn. This was out of the way of the corn pickers and still low enough for the water, which was turned in the same afternoon they were planted, to settle the dirt thoroughly about the roots. The corn proved a first-class shade for the new plants till they got started.

Obviously bands of three rows of sweet corn are good shelter in the hot season for the blocks of low vegetables they enclose against hot dry winds. Corn should not be planted in single rows as pollination is apt to be only partial and ears scantily filled.

Varieties.—Every one wants early corn, and the early varieties are about the only kinds that can be grown on some uplands without irrigation. They are small in growth, rapid in ear and best wherever the season is shortened either by lack of moisture or heat. Some later varieties are sweeter, however, and larger in the ear, and should be grown wherever possible.

Early Cory: very early, good-sized ear, small cob well filled.

Golden Bantam: very early, ears medium size; kernels yellow, rich and delicious—a surprise to those unaccustomed to such quality in a yellow corn.

Early Adams: a dwarf, small cob variety, popular in Imperial valley for earliest crop.

Large Adams: freer growth, also very quick to mature; good for late planting for fall crop.

Crosby's Early Sugar: very early, short ear, sweet and productive.

Early Minnesota: very early, good ear, white cob, excellent quality.

Early Mammoth: medium early, largest ears of the early varieties, cob white, large and well filled, productive and of good flavor.

Black Mexican: ears rather short, cook white, very sweet, ripe kernel black.

Oregon Evergreen: early, large, rich ear; husk resists wilting; popular with market growers.

Country Gentleman: large ears, very sweet, tall, very productive.

Golden Cream: a yellow country gentleman of high quality.

Stowell's Evergreen: a standard late variety, commended by all, large ears, deep grain, tender and sweet, a strong grower and productive.

Stabler Early: early; small kernel; good table variety.

Forage Corn.—Sweet corn is constantly increasing in popularity over common field corn for green and cured forage for cows. Late Mammoth and Stowell's Evergreen are largely used for this purpose. In farm garden practice more attention should usually be paid to the forage value of the stalk. If cut and cured as each stalk is robbed of its ears, it is more nutritious than if allowed to bleach in the sun until the whole field is cleaned up.

FIELD AND SILAGE CORN.

The growth of corn in California as a grain or silage crop is out of the view of this treatise. An interesting publication on the subject can be had from the Experiment Station at Berkeley. During the last decade silos have multiplied in various parts of the state and a much greater acreage of field corn has been grown than formerly. It is chiefly grown in rows and somewhat less carefully than corn for grain, because the plant is not required to meet the strenuous requirements of grain for ripening. Still the better the growing the better the crop. A hardy, vigorous, tall growth is important for silo filling. Varieties chiefly grown are the Leaming, which well meets these points and is the most popular of the yellow varieties in California, and Sanford White Flint, and Hickory King hold about the same place among white sorts. In the Imperial valley Mexican June does better than varieties of eastern origin. The Red Cob Ensilage is a strong growing, short jointed and leafy variety especially selected for silo purposes.

Very little suckering of corn is done in California. The grower may either get more corn by suckering or that the corn he does get will be better developed by preventing diversion of sap from the main stalks, it is becoming more clear that enough is not gained in either way to pay the cost of suckering.

Corn After Grain Hay.—W. D. Trewhitt, of Kings, averages eighty bushels of corn after taking off a crop of wheat or barley hay from the same land each year. The corn is usually planted the latter part of June after the land has been irrigated and plowed good and deep. As soon as it gets above the ground cultivating is done as long as possible, usually three times. One irrigation is made after planting, when the corn is just beginning to tassel out.

POP CORN.

Pop corn is grown in California to some extent but much is brought from the East. Most of California popcorn is grown in Los Angeles county. The demand for California popcorn is strong because it is raised in a temperate, dry climate, where irrigation is taken off when the silks begin to turn, drying the kernels and cobs so the corn is ready to pop four weeks after picking. Eastern corn must cure three times as long. Robert Haengge of Inglewood raises about 40 acres every year; and eastern field corn does not grow more thriftily. It stools out often eight or ten stalks from one kernel and each stalk averages about two salable ears.

TAMALE COVERS.

A by-product of the corn field is the tamale wrapper for which a variety of corn with a thin paper-like husk is required. Two or three hundred pounds may be had to the acre, and some estimate about one ton of husks to six tons of corn. On harvesting for both

Cantaloups from horizon to horizon in Imperial Valley.—Page 210.

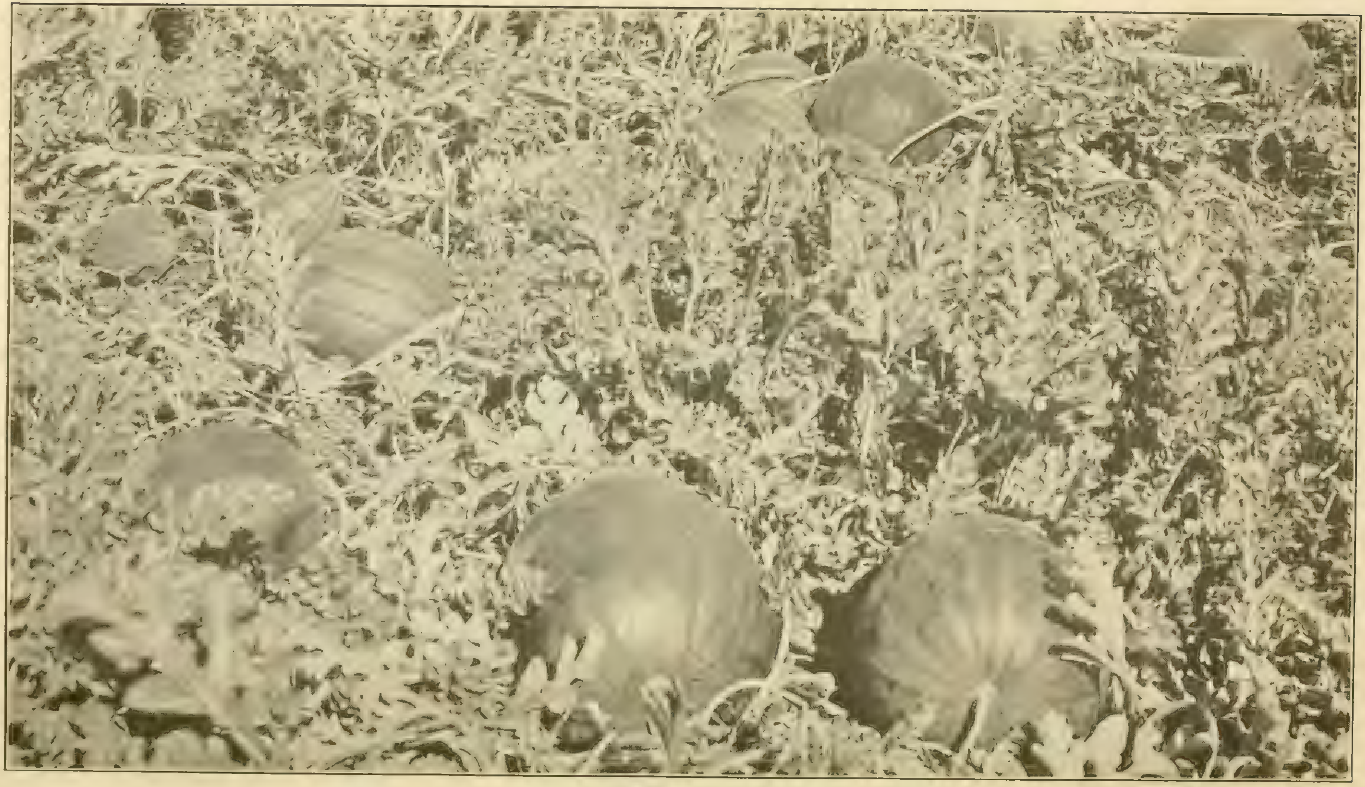


Photo Sacramento Co. Supervisors

Growth and bearing of watermelons on moist riverside lands.—Page 213.

corn and husks the ears are broken off from the stalks entire, and placed in convenient piles, around which the operators sit while breaking or cutting out the ears without great disturbance of the coverings, which are placed in neat bales of about sixty pounds each, in which they are sent to the buyer. The price is variable, and has ranged in different years from four to fifteen cents a pound.

CHAPTER XXI.

THE CUCUMBER.

CUCUMBER.—*Cucumis sativus.*

French, concombre; German, gurke; Dutch, komkommer; Danish, agurken; Italian, cetriolo; Spanish, cohombro; Portuguese, pepino.

The cucumber is rather an exacting plant and seldom yields anything but disappointment to the grower who does not give it the most watchful care and generous supplies of food and drink. It is very sensitive to frosts, nor does it thrive in low temperatures even if free from frost. It rejoices in heat, but it abhors drought. It is not content, like some members of its botanical family, to thrive in dry heat if it can find moisture below; the heat reflected from a dry surface and interior sunshine beaming through dry air brings distress to its foliage. For these reasons it usually resents location on interior plains unless it can have abundant moisture and some protection from heat—such at least as locally may come from modifying the air immediately around it, by evaporation from water standing near. Modified interior conditions such as are found on river-side lands, or moist lowlands often yield fine growth and productiveness, but even there it is often necessary to keep the moistuse close to the plant by irrigation. In coast valleys where heat and moisture are well balanced and on soil rich and moist by cultivation the plant may be productive enough without irrigation, but as a rule even in parts of coast valleys where the heat runs high, as ocean influences are reduced, not only is occasional irrigation needed, but constant supplies are the price of thrift in the plant. For these reasons the placing of cucumbers along the main ditches where water frequently or always flows, or the use of a raised bed with water flowing on the ridge, is the surest way to make the plants satisfactory and prolific where the heat runs high. And yet, as stated, there are considerable areas in different parts of the state where conditions are so favorable that field growth of cucumbers for the market and for the pickle factories, is feasible without irrigation. There are moist lowlands, rich and warm, where the foliage does not show burnt edges and where the free growth of vine is marvelous to one who has tried to push the plant in places too trying for it. It is also possible in frostless regions where heat comes early in the spring, to find conditions for an early crop which is disposed of before trying summer conditions come on. Early spring conditions in California are widely favorable to the plant did not the frost factor intrude. Autumn growing is also practicable where moisture is adequate, for then heat and drought are modified. Cucumbers from the open ground at Thanksgiving or later are common in some regions.

Soil.—Cucumbers require a rich soil, and it must be retentive of moisture, for the reasons stated, unless water is to be constantly supplied. A rather light soil which warms up early is preferable, but heavy soil can be readily adapted to cucumbers on a small scale by free use of well-rotted manure thoroughly mixed. A free loam, not disposed to bake, is the best soil.

Preparation of Soil.—Land from which a well-cultivated root crop has been removed for winter use can be easily put into condition for cucumbers by good deep spring plowing and harrowing, to retain moisture. New land should receive such fall and winter treatment as has been prescribed for bean planting, so as to secure in spring as good tilth and moisture retention as possible.

Planting and Cultivation.—Cucumbers are usually grown in hills, from four to six feet apart each way. Planting should not be done until the soil becomes warm and frost injury is over; then planting five or six seeds in a hill, covering as lightly as can be trusted to retain moisture until the plants take hold. As soon as the plants appear, cultivation must begin, using the horse between the rows and the hoe around the plants. The surface must be kept mellow and free from weeds. If the plants all grow select the best two or three and pull out the others. Continue cultivation as long as it is possible to stir the soil without injuring the vines.

Field planting is sometimes done by turning furrows eight feet apart, planting the seed on each side of the furrow, having the hills at least four feet apart in the row; train the vines away from the furrow and use the furrow to run the water in, keeping it away from the plant and the fruit.

Gathering.—Frequent gathering of the cucumbers as they reach satisfactory size is essential to the long bearing of the vines. None should be allowed to ripen except on vines planted for that purpose, and all imperfect specimens should be taken off as soon as seen.

Cucumbers Under Cover.—Very little is done in California in house-growing of cucumbers. A little forcing is done by market gardeners, but the business is risky because of the slight demand and the fact that open-air cucumbers from early regions come so soon after the late crop from frostless places is disposed of. Growing under cover of glass or cloth is done without providing artificial heat. The natural temperatures and protection from frost are relied upon. It is quite common to start plants under cover, and plant out early even at risk of replanting. Growers usually keep a stock of plants ready for this purpose.

Garden Culture of Cucumbers.—In the garden very elaborate arrangements may be made to secure early cucumbers. Growing the plants on inverted sod and planting out as a whole hill, as described in Chapter XI, is satisfactory. Planting on the sides of ditches has already been mentioned. Growing hills or single plants in tin cans or other receptacles and protecting them until safe to plant out is also an easy way to get an earlier crop than otherwise. This method is in fact employed on quite a large scale by Chinese growers in the Marysville region of the Sacramento valley in this way: About the latter third of February, the time varying with the season, the seeds are planted in old tin cans that have otherwise outlived their usefulness, to give the plants a good start in spite of frosts. Rich soil with lots of manure is used in the cans, and after the plants are a couple of inches high, and weather permits, the cans are split open so as to let the roots out without disturbing the soil, and set out in raised beds, where they start bearing about the middle of May. The cucumbers are picked every morning and are well irrigated and the next morning are ready to pick again. They have about a two months' start in the market over the bay districts and the San Joaquin truck gardens.

Some use is made of deep holes partly filled with tramped horse manure and then with earth and growing plants on top of the hill thus formed, protected with glass or cloth. With such arrangements double care must be had to supply enough water. The south side of a fence or building is a good place for fast spring growth. In short, moderate heat, copious watering and rich soil are the secrets of good cucumbers, and there is much chance for ingenuity in securing these conditions.

For pickling.—Cucumbers for pickling are largely grown in the early autumn from midsummer planting. As stated before, where irrigation can be had, autumn temperatures are often very favorable for the plant.

Varieties.—Although our county fairs may be counted upon to bring to view almost every shape and length of cucumber which amateurs delight in, very few kinds constitute the crop grown for use:

Arlington White Spine: good size, straight and symmetrical, holds green color well, very productive and early; used both for market and pickling.

Evergreen White Spine: a standard mid-season variety, large, dark green, tender, white crisp flesh.

Klondike: similar to Long White Spine, specially favored by southern California market growers.

Long Green: an old standard late variety; dark green; firm and crisp; good form; a favorite for pickling.

Green Prolific or Boston Pickling: early and productive; small size; crisp and tender; popular for pickling.

Everbearing: very early and prolific; medium length, thick; rich dark green.

Davis Perfection: long, slender, good green color, and flesh white and crisp; flavor excellent; commended for family garden.

Cumberland: hardy, vigorous and prolific; very desirable for pickling because very good in all sizes.

Chicago Pickling: medium long, dark green, rounded ends; a popular pickling variety.

Cool and Crisp: especially favored as a garden variety; green but ripening white.

Lemon: resembles its namesake in shape and color and is used when yellow; eaten as plucked from vines; also used as are other cucumbers; becoming popular.

CHAPTER XXII.

EGG PLANT.

EGG PLANT.—*Solanum melongena.*

French, aubergine; German, eierpflanze; Flemish, eierplant; Italian, petonciano; Spanish, berengena; Portuguese, bringela.

Egg plant is one of the great vegetables in California; it is great in size and quality, which are easily attained, and great in its popularity. It is doubtful whether any part of the world makes such free use of the plant, and enjoys it through so long a season. Although the plant is properly classed as tender, and is somewhat exacting in the starting of the seed and in transplanting, it grows riotously when well established in a favorable location and soil; fruits freely and continuously, and it is not unusual to find at California fairs specimens of six pounds' weight, while fruit of two and three pounds constitute common stock with the vegetable peddlers.

Location and Soil.—Egg plant can be successfully grown almost everywhere in California, but there will naturally be much variation in its season, according to the local occurrence of the frost-free period. In the frostless belts, described in previous chapters, it is feasible to start the plants in the autumn and secure a very early crop; in most places, however, the plants can best be grown with bottom heat in the winter, and fruiting secured all through the summer and fall, if the nights are rather warm and the dry heat not too fitful.

As the plant will endure very high heat if well supplied with moisture, and as it resists drought, when well established, it is well adapted to interior conditions. It succeeds admirably in the interior bottom lands if water is not excessive, and is perfectly at home as well in the coast regions, both valley and uplands, if adequately watered. It is not very exacting in soil character, and can be safely undertaken on any good garden land if well cultivated and manured; for the plant is a strong feeder and should grow fast and regularly.

Growing the Plants.—Egg plants can be easily grown from seed by the use of seed-boxes, with bottom heat or in an ordinary hot-bed, all of which are described in the chapter on propagation. The seed should be covered about half an inch. Extra regard must be had for maintaining a uniform and rather high temperature for the starting and early growth of the seedlings. Transplanting the seedlings, into other seed-beds or cold frames, twice before planting out renders them more stocky. Planting out should only be done when the soil is warm and in good moist condition, for it is necessary that the seedlings should quickly take hold and proceed vigorously afterward. Plants may be grown from three to four feet apart each way.

After Treatment.—The best of cultivation must be given to prevent any check or setback in the growth of the plants. Irrigation must be used as necessary to advance this result. It is desirable that the plant should be prevented from setting too many fruits, and pinching off the terminals to prevent too great running out is often advisable. It is also desirable to dispose the fruits so they do not enlarge upon each other.

Varieties.—The New York Improved Purple is the favorite variety and is chiefly grown. Black Beauty, a deep purple, a little earlier but usually not quite so large is also popular. Other sorts, though much less popular, are the Early Long Purple and the Black Pekin. The White Pearl is the best of the whites which are, however, in less demand. The Tree Egg Plant is hardy, upright and escapes some ills of lower growing varieties in bad weather.

CHAPTER XXIII.

LETTUCE.

CABBAGE LETTUCE.—*Lactuca capitata.*

French, laitues pommées; German, kopfsalat; Dutch, kropsalad; Italian, lattuga a cappucio; Spanish, lechuga acogollada; Portuguese, alface repolhada.

COS LETTUCE.—*Idem.*

French, laitues romaines; German, bind-salat; Dutch, roomsche latouw; Italian, lattuga romana; Spanish, lechuga romana; Portuguese, alface romana.

Lettuce is emphatically a satisfactory garden plant in California. It is unaffected, except in slower growth, by the ordinary winter temperatures of our valleys and foothills, and it endures the heat, if moisture is adequate, with only slight protection from the burning sun. It withers and dies or it becomes tough and worthless, in the face of drought, it is true, but any gardener who does not arrange better for its growth does not deserve to enjoy its refreshing crispness. Whoever will provide the simplest arrangement to relieve its roots from cold, standing water in winter, or who will keep its roots moist and afford slight shade for its tender leaves from the interior heat in summer, need never miss a day of lettuce-gathering. And even these slight aids from the grower are not needed everywhere. In regions naturally moderate, both in moisture and heat, and with a few weeks of watering in midsummer, succession of lettuce is unbroken throughout the year on any good garden soil which is well cultivated. There is little lettuce forcing in California, and, of course, with such natural conditions, there is small need of any, and yet during recent years, owing to the constant demand for lettuce all the year, because of the increased importance of salads in the menu, there has arisen new opportunity for forcing and shipment of lettuce considerable distances by rail has advanced notably during the last decade. In central California cities during the season of heaviest rains it is hard to get bright, clean lettuce from local market gardens and much is brought from southern California, where there is less rain and more winter sunshine. In addition to such movement within the state, about 1500 carloads are annually shipped beyond state lines. From Imperial county during March and April about 500 carloads and from Los Angeles and Orange counties from November to June about 1000 carloads are shipped. This product is distributed through eastern states and Canada. In addition to the foregoing, which is estimated to occupy about a thousand acres, there are perhaps five hundred acres in commercial lettuce growing in the districts of San Francisco, Sacramento and Stockton. All of this is grown in the open air. It is to be expected that as population increases there will be a better opportunity for local forcing enterprises which can be conducted with slight structures and a minimum of artificial heat.

GARDEN CULTURE.

Lettuce can be sown on moist ground the year round. It is exceedingly rapid in development (from seed to head in fourteen weeks, perhaps) and can be grown as a catch crop among slower growing vegetables at all times of the year. It starts readily from the seed, and the most common practice is to sow a thin drill of it here or there, as interspace is to be for a short time unoccupied, thinning the plants at the first weeding and allowing them to head in the thinned row. This is the simplest practice, and will be most generally followed in the farm garden. And yet it is so easy to imitate the market gardeners and put in transplanted lettuce here and there, wherever an unoccupied corner appears, that this practice must be urged even for the simplest gardening.

It is possible to grow about thirty thousand heads to the acre by proper laying off and culture. Plants 14 inches apart in rows 16 inches apart is a good lay-out for hand cultivation. Transplanting should be done when the ground is moist and irrigation should soon follow planting unless rain comes.

Wherever a winter or early spring vegetable is cleared away a due share of lettuce should go in. Wherever a summer vegetable yields the ground, the soil should be well soaked and cultivated and the lettuce should not be overlooked. As soon as the fall rains sufficiently wet the ground, lettuce should be among the first sowings. And before the winter comes on, with its heavy rains, a warm ridge or raised bed should have its lettuce covering underway so that midwinter shall not lack its supply of salad. And in February, as the ground is again suited for flat culture, new sowings of lettuce should be among the first things done. Thus it is seen that lettuce is to be sown all the year and plucked all the year in California.

It is not necessary, perhaps, to sow lettuce so often if seedbeds are prepared so that they will readily drain away winter water and have slight protection from cold winds in the winter and burning sun in summer. From these beds plants can be taken at different times as land is available for planting out, just as cabbages are transplanted, and even though the plants have attained considerable size in the seed-bed, the long roots can be shortened a little and, if not too large, they can still be transplanted to good moist soil, and will go on with heading all the better for the freer space. Seed-beds should not have much heating material in this climate. It is better for the plants to grow slowly at first, and after the rains a raised bed with enough fibrous material and well-spent manure will furnish a long succession for transplanting. But whether the ordinary grower will undertake this work or not, let him have lettuce anyway—even if he will only scatter seed at frequent intervals on moist ground and then give the plants good hoeing. To get crisp, tender lettuce the plants must be pushed along with rich soil and good cultivation whatever method of growing is pursued.

In the hot parts of the state, where the summer tries the plants, lettuce should be planted on the shady side of tall growing vegetables, and then, with moisture enough, they will do well. Lath screens or other devices are, of course, serviceable if one prefers them. But do not be content with a little lettuce in the spring and go without the rest of the year. It only requires a little ingenuity and energy and water to have salad all summer. Even if the grower does have to face the vexation of plants going to seed in the extreme heat, he should persist in his effort.

COMMERCIAL LETTUCE GROWING.

Details of commercial lettuce growing are faithfully set forth by Prof. S. S. Rogers, of the University Farm, who has given particular attention to this subject for several years and has written a special publication* from which we draw both text and illustrations.

For the interior valleys of the state the planting season generally starts during the last of August and continues until the first of March. Many growers make a first planting of the seed from the middle to the last of August, a second in October, and a third during January and February. Along the coast, where the climate is more moderate, it is possible to grow lettuce successfully during any month of the year.

There are two methods for growing lettuce, both of which are used extensively in California. The first is by planting the seed directly in the field, sowing it in drills on the borders of the raised beds; the second is to sow in seed-beds and transplant the young plants into the field when they have attained the desired size.

There are several forms of seed-beds in use, the most common being the sunken beds, which vary from three to six feet in width and eight to fifteen feet in length. The earth taken from the bed is hoed up to form a levee around it to aid in irrigating. Before planting, a heavy coating of well-rotted manure is spaded under and the soil is heavily irrigated just before seeding. The seed may either be broadcast or sown in drills, and covered one-half inch. If the soil is liable to run together and bake when irrigated, a thin coating of well-rotted, screened stable manure should be applied on the surface before seeding. It will aid in germination if strips of burlap are placed on the soil to remain until the young plants are appearing at the surface. In removing this covering the young plants should not be exposed too suddenly to the light. During the warm months it is often necessary to irrigate several times before the young plants appear. The water may be applied either through a sprinkler or by flooding, using only a small stream so that the tender seedlings may not be injured. The amount of irrigation which the beds will need depends largely upon the character of the soil and the season of the year. During the early fall the beds are often irrigated three or four times a week, while later in the season one or two irrigations will prove sufficient. When the plants are one and a half or two inches tall the beds may be weeded and the plants thinned, leaving the distance between the plants not less than one inch.

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*Circular 160, University Experiment Station, "Lettuce Growing in California," by Stanley S. Rogers, March 1917.

Under ordinary conditions the plants remain in the seed-beds six weeks, although the time will vary from one to two months with the season of the year and care of the plants. When planting directly in the field three to four pounds of seed will be sufficient for one acre; in seed-beds for transplanting at the University Farm Garden, 2600 square feet of seed-beds raised plants enough for one acre.

When quick-growing plants are desired the seed should be sown in hot-beds in preference to the open beds. This is occasionally done during the winter and early spring.

Lifting the Plants.—Plants may be transplanted when they are from two to four inches tall, the larger size being preferable during the warm weather. Before removing, the plants should be hardened by stopping the irrigation a few days in advance so that their growth may be checked. A few hours before the plants are to be removed they should be thoroughly irrigated in order that as much soil and as many fibrous roots as possible may be taken up with the seedlings. There are two methods for removing the plants. Those who have had considerable experience may pull them by hand. Those with limited experience, and especially if the soil is of a heavy nature, should dig them with the aid of a trowel or shovel. The plants should be constantly covered until they are planted in the field and not exposed to the sun. If the seedlings are too large, the leaves and roots should be cut back—the top three inches tall and roots two inches long.

Preparation of the Soil.—The soil should be in the finest possible condition and free from all weed growth. Many growers apply from fifteen to twenty-five tons of manure per acre. This should be applied long enough in advance of planting so that it may be plowed under and completely rotted by the time the field is ready for use. In the fall before the rains have commenced, the field should be heavily irrigated before plowing, but in the winter and spring months there is generally a sufficient amount of moisture without irrigation. After the soil has been worked into good condition, raised beds or ridges should be made by the use of a special cultivator attachment. The beds should be from twelve to eighteen inches wide, four to six inches high, and the spaces between them ten to fifteen inches—extending to main ditches or across the field.

Planting.—The distance between the plants in the field varies from eight to fifteen inches. Where a variety producing large heads, such as the Los Angeles, not less than twelve inches apart, in rows twelve inches apart is best, but if a smaller variety the spaces may be slightly reduced. If he seed has been sown directly in the field the plants should be thinned when they are from two to four inches tall, and the vacant spaces filled with those removed while thinning.

Irrigation.—A few days before planting, the field should be irrigated in order to settle the earth in the raised beds, and to show how far up on them the water will come. If this is not done many of the plants will be so high on the beds that they will not receive sufficient water, while others will be so low that they will be injured from an over-supply. As soon as the plants have been transplanted the field should be thoroughly irrigated, and it is especially important while they are young that frequent irrigations be given. In applying the water care should be taken that it is not allowed to flow over the tops of the beds, and it will be found much more satisfactory to use a small stream, allowing it to run between the beds slowly, and thoroughly soaking into them, than a larger stream flowing more rapidly.

The number of irrigations which the field will require can only be determined by the condition of the plants. It is sometimes desirable to irrigate every week throughout the season, while under other conditions one or two irrigations will be sufficient. There should always be an adequate amount of moisture in the soil from the time the plants have commenced to head until they have matured, because the character and size of the heads is influenced to a great extent by the quantity of soil moisture present.

During the late spring if it is desirable to hold the crop in the field for a short time after it has matured, no more water should be applied, as it will increase the liability of the plants going to seed.

Cultivation.—When raised beds are used all cultivation is done by hand, the field being hoed from one to five times during the season, depending upon the soil, the weed growth, and the thoroughness with which the beds have been made and irrigated. The soil need not be hoed between the beds unless there is a heavy growth of weeds. Occasionally water will flow over the tops of the beds and these low places should be hoed after each irrigaion if the soil has a tendency to run together, for the growth of the plants will be retarded if he earth close to them is allowed to harden.

Harvesting.—The time required to mature a crop of lettuce varies with the season, the character of the soil, and the care. Plants set in the field during September should mature during November and December. Plants set in the field during November will mature from February to April, inclusive, and those transplanted during February and March will mature from April to June.

The period of growth at which the crop should be harvested depends largely upon the season, market requirements and prices. The California market demands a large solid head and the crop should remain in the field until it has reached this condition.

Chief Lettuce Troubles.—A good full field or garden bed depends upon good seed and careful attention to cultural requirements which have been outlined.

During winter and spring, especially on heavy soils, there is danger of stem-rot. The plants become sickly yellow and the stems rot at the surface of the ground. Diseased plants may appear scattered throughout the field, or in well-defined areas. This is a fungus disease which thrives best under excessive moisture conditions. For control improve the drainage and make the beds high enough so that the water will not stand directly around the plants.

Sunburn is manifested by a blackening of the edges of the leaves inside the heads. The cause is a period of excessive hot weather from the time the plants are half-grown until they have commenced to head. Planting in the fall or early spring will largely control this disease; if the weather is very hot and dry during the spring the plants should be irrigated frequently.

Failure to produce solid heads is caused either by a poor quality of seed, an insufficient supply of moisture, or unfavorable climatic conditions, such as excessive hot weather while the plants are maturing. Use only well selected seed and apply sufficient moisture at the time the heads are maturing. During the late spring when the weather is hot the crop should be harvested immediately after the heads have matured.

Varieties.—There is almost illimitable variety in lettuce, and inextricable confusion in the nomenclature resulting from renaming by seedsmen and others. As with other plants, however, a few varieties constitute the bulk of the California lettuce product. It is customary to arrange lettuce varieties in two groups; one has roundish heads and includes the "cabbage" varieties; the other has elongated heads and includes the "cos" varieties. There is, of course, much difference in the density of the heads, and some are quite loose and open, but the close-heading varieties are better and the more suitable for market handling. In California the cabbage varieties very largely preponderate over the cos varieties, and the non-heading or "cutting lettuces," or curled varieties, are not widely grown, though they may be found useful in getting the quickest foliage from the seed sowing. It should be noted that compared with the cabbage type, the cos lettuce is hardier and less susceptible to frost; it also shows more ability to withstand drought and is also less liable to sunburn, the last two features making it better adapted to hot and dry localities, while the first is one which especially recommends its use as a late kind. And yet the firm-heading varieties are overwhelmingly superior commercially and are secured by growing them in different districts at seasons of the year which afford the conditions which they require. The following are popular varieties in California:

Los Angeles, renamed New York Market: very large, round head, crisp, white, good flavor; the best shipping variety.

Iceberg: stands heat and is less liable to go to seed; resembles Los Angeles variety, but also reddish tinge on leaf-edges.

California Cream Butter: large, solid, round heads, light green; spotted and tinged with brown; creamy yellow within; stands heat well, particularly popular for autumn and winter use; resembles Big Boston.

Big Boston: a light green cabbage variety with light brown tinge to the leaves; largely grown in the south for northern shipments; forms a fine head, endures temperature changes well.

May King: a very early, quick heading variety, colored like Big Boston; good for spring and summer use.

White Paris Cos: upright grower, with long head; needs tying up for blanching; tender and crisp, a favorite with foreign residents.

Improved Hanson: heads round, very solid and large, green outside and white within; flavor fine; stands heat well; very popular for house gardens.

Prize Head: an early variety with large, loose bunch, remains tender and crisp through long season; flavor excellent; very easily grown.

The Morse: large, non-heading variety forming large bunch of loose leaves, crisp and of fine flavor.

Denver Market: early, tight, conical head; light green, leaves curled and crimped; crisp and tender; very slow to go to seed.

Early Curled Simpson: an early non-heading variety, leaves almost white and very large; stands heat well.

Other varieties locally offered are "Wonderful," commended in southern California; "Tennis Ball," resembling "California Cream Butter" but smaller and pure green; "Marblehead," an all-the-year variety of high quality; and many others which will delight the amateur.

CHAPTER XXIV.

MELONS.

The Cantaloup or Muskmelon.—*Cucumis melo.*

French, melon; German, melone; Dutch, meloen; Italian, popone; Spanish, melon; Portuguese, melao.

The Watermelon.—*Citrullus vulgaris.*

French, melon d'eau; German, wasser-melone; Italian, cocomero; Spanish, sandia; Portuguese, melamia.

From the manner in which they are eaten melons should be classed with fruits; from the manner in which they are grown they are more closely related to vegetables. Their nearest botanical relatives, also, are of the vegetable class. They evidently cannot be excluded from this work because of their aspiration to rank with the fruits.

California is characteristically great for melons; not only for their great size and excellence, but for the long season during which they are available for table use. Their delight in interior heat, their tolerance of drought, their immense size, when both heat and moisture combine for their advancement, constitute exceptional adaptations for semi-tropical climates, in which they have been famous from the earliest times. California answers their needs to the fullest degree, and they have naturally attained great local esteem and popularity. The length of the frostless season and the varying degrees of spring and summer heat in different parts of the state give us command of early and late melons beyond that of any other part of the country, as will be noted presently. For this reason California melons have during the last decade and a half figured largely in national trade eastward and in shipment to northern Pacific ports. California's position in the melon production of the United States is shown by the Monthly Crop Report of the U. S. Department of Agriculture for June 1917 to be as follows:

Acreage of cantaloups................	17,300
Products in crates	3,206,700

Of this acreage and product, which comprises about 9000 carloads, three-fourths are credited to the Imperial valley and one-fourth to the San Joaquin valley. California produces 41 per cent of all the cantaloups of the United States and leads all the states, her nearest rival being Georgia with 6700 acres. In watermelons, however, the situation is reversed and Georgia leads the country by a large plurality in acreage and product. An ingenious statistician has figured out that California's total cantaloup crop can supply every individual in the United States with one melon each, leaving fifteen more for each Californian.

THE MUSKMELON.

In the United States the terms "muskmelon" and "cantaloup" are interchangeable, and in California cantaloup is given the preference. This all seems somewhat at variance with European practice, where the varieties with netted coats are "muskmelons" and those with scabby or knobby skins are "rock melons" or cantaloups. According to this classification, the varieties we chiefly grow in California are not cantaloups at all, but it will be difficult to have them called by any other name. Of the many types of cantaloups which have been defined by students of melon classification a single one, known as the Rocky Ford, from the place of its first large commercial development in Colorado, dominates all others, constituting almost exclusively the commercial production except that which is especially grown for local markets—aside, of course, from the winter melons, which are a distinct class, as will be noted later.

The muskmelon has a very wide range in California. It has greater taste for dry heat than its relative, the cucumber, but in this respect it is no rival of the watermelon, for it will perish utterly under drought which the watermelon will survive. Where the muskmelon has both heat and moisture, and is of large variety, it grows riotously, for a weight of seventy-two pounds has been reported from Fresno. But the muskmelon will not brook frost, nor will it thrive with low temperatures even if they are considerably above freezing. As has just been stated, however, California has such a long frost-free period and as degrees of favoring heat arrive in different months in different parts of the state, there is wide divergence in dates of planting and of ripening of the crop. The earliest cantaloup district is the Coachella and Imperial valleys in the extreme southeast corner of the state, where 12,700 acres were grown in 1917. Planting is done in February, and the crop shipment begins in May and reaches the eastern markets in advance of the product of Colorado and other interior states. In the San Joaquin valley planting may be in April and the product follows the Rocky Ford shipments for the later summer trade of the Atlantic cities. Just what trade can be profitably done at different dates in the East is not fully determined, but the advantage of the very early cantaloup from California seems unquestioned. It is clear, however, that by choosing different parts of the state and different varieties of cantaloups, including the "winter melon" class, California can furnish the fruit from May to December in any quantities the available price makes profitable.

Garden Culture.—The soil requirements of the muskmelon are quite like those already described for the cucumber. Most of the commercial crop is produced on deep, rich, warm loams, but heavier soils with good culture may be used. Some varieties seem to enjoy a heavy soil better than others. Preparation of the soil is the same as for cucumbers, and the same methods for starting plants for planting out as well as for furnishing warmth and richness in the hill may be used in garden practice. Growing groups of seedlings in small receptacles for planting out in hills without disturbing the roots, as described in Chapter XI, is a good way to get an early start. In the interior, on the naturally rich loams, not only is the culture devoid of all forcing devices, but on moist river bank or bottom soils the early crop is sometimes grown without irrigation. For summer planting and the continuation of the muskmelon supply late in the fall, ample moisture is necessary, and a modification of interior heat by intrusion of coast breezes is desirable. The late summer product is most easily grown in the coast valleys, somewhat protected from ocean winds.

FIELD CULTURE OF CANTALOUPS.

There are so many ways of handling the soil to secure fine tillage and aeration and adequate moisture without the evil of surface flooding that it can be hardly claimed that any one routine is best. As involving tillage, irrigation by percolation and fertilization, which the plant enjoys under proper conditions, the following outline, condensed from the writings of Dr. R. H. Forbes, of the Arizona Station, is very suggestive for California interior valley conditions. The writer has made some additions from his own observations: Cantaloups are grown to excellent advantage on light warm loams properly fertilized by the addition of the organic matter and nitrogen in which our desert soils are usually deficient. Heavy soils may also be used for cantaloup culture, but are less easily prepared and tilled during the progress of the crop. Old alfalfa ground is most excellent for cantaloup culture, and well-rotted barnyard manure is effective. Bermuda sod plowed up and exposed to the sun without irrigation the preceding summer makes excellent cantaloup ground, the intensive cultivation necessary serving both to benefit the crop and to restrain this formidable weed. Trash from sod-turning can be reduced by the use of a disk.

Alkaline lands should be avoided, since soluble salts in excess, even though insufficient to kill the plants, are commonly believed to be detrimental to the quality of the melons.

The land should be so laid out that the rows may be irrigated without submerging the vines and the fruit. One good way to accomplish this, and also to fertilize the soil, is as follows: The field is first irrigated, plowed and harrowed to a condition of fine tilth. With a 12-inch plow, at intervals of six feet, double furrows are then broken out, going and returning along the same lines. In the deep, wide furrows thus formed well-rotted barnyard manure is distributed to a depth of three or four inches, then plowed in and the field again harrowed level. By then plowing toward the middle of the spaces between the fertilized furrows, the soil is finally left in oval ridges separated by back furrows for irrigation. The rough furrows and ridges are then finished with a harrow and the newly prepared ground irrigated to establish the water line for guidance in planting.

Seed should be most carefully selected with reference to flavor and appearance of the fruit; to good shipping characters, including small cavities and heavy netting; and to a tendency to produce melons of standard size. About one pound of seed is required for an acre. Cantaloup seed improves to some extent with time, and is stated by experienced growers to give more satisfaction at two years of age than at one.

With irrigating furrows six feet apart, rows may be planted one on each side of each furrow. The hills should be ten feet apart in the rows, "breaking spaces" between rows. On this plan the ground will be quite uniformly occupied, with a distance of about six feet between adjacent hills. Where winds are strong and prevalently in one direction it is sometimes desirable to lay off the lands at right angles to the course of the wind and plant all the hills on the windward side of each strip so that the vines are trained by the wind away from the ditch and not half of them blown into it.

With a hoe each hill is planted by making a small furrow a foot long just above the water line, made by the preceding irrigation which places the hill where it will not be flooded by later irrigation. About ten seeds are dropped in this furrow, covered an inch deep, and the soil pressed down lightly with the blade of the hoe. After early plantings, when frosts are feared, a second set of hills may be planted alongside the first, ten days or two weeks later. When danger from frost is past, while the plants are still small they are thinned to one or two of the strongest to each hill. Care must be taken not to overcrowd the ground with vines, as a high percentage of small melons will follow. Under Arizona conditions the six-foot spacing of hills recommended above, with not more than two plants in the hill, gives best results.

A dependable supply of irrigating water is essential to successful cantaloup culture in regions of little rain. Early in the season when the plants are small and the irrigating supply is cold, water should be applied sparingly. But between the setting of the crop and the ripening of the first fruits, when both vines and melons are developing rapidly and when the weather is usually hot and dry, frequent and copious irrigation is necessary, for if water is stinted at this time a larger percentage of small or pony melons is likely to follow. To prevent this, even during the picking season, water should again be sparingly applied—just enough to prevent the vines from wilting. This also gives quality and solidity to the melons.

As long as the vines will permit, the middles should be kept free of weeds by means of a one-horse cultivator, and the furrows run through with a small plow after each irrigation. The young plants should also be hoed by hand two or three times. When the ground is once more covered with vines weeds will make but little headway, even Bermuda grass being effectually checked by the dense cover.

Imperial Valley Methods.—Alfalfa land is preferred. It is first plowed three or four inches deep, then about a month later is plowed seven or eight inches deep. The "hard" finely divided "gumbo" soil may produce larger crops if properly worked; but the "soft" land in which more or less sand makes it more loamy and warm, produces the earliest.

Wide rounded ridges about eight feet from center to center are made with narrow furrows between. The seed is planted half way up one side of each of these. This puts the roots close to irrigation but keeps the plants out of it largely, and spreads them out to sun and air. On the early plantings, some of which are put in late in December and early in January, a pointed cap of oiled paper is placed over each hill as it is planted by hand to hold the warmth of the ground and protect the seedling plants from frost. Later plantings are done by machine and not covered with the papers.

The cantaloups are irrigated according to soil conditions. The ground must not be dried very deep. In hot weather it dries enough to walk on in the day. Water is not allowed to cover the seeds or get around the plant stems. During picking especially, water is applied every three or four days, the pickers walking on the ridges when the furrows are wet.

Three or four cultivations are all that can be given on account of vine growth. To control aphis burn the plants on and all around an infected area as soon as it is discovered, usually during picking time.

Turlock Methods—Early in January the land is plowed eleven or twelve inches deep to get a soil reservoir for winter rains and to turn under the manure, which is applied thinly all over rather than heavily on a part each season. Strawy manure is likely to "burn out the ground" in this sandy soil and should be worked in well and deep. The next plowing is six or seven inches deep early in March, just before planting time, which is about March 15 if the soil is warm and the rains over. If rains crust the soil it must be broken with a light spike harrow even if some plants are injured.

It is customary to omit every ninth row for a driveway for convenience in picking season, but it may be better to plant all rows and break driveways crosswise with a harrow, just far enough apart, about 10 rods, so that a picker commencing at one drive would pick a row and arrive at the next drive with his sack full. It would be dumped there, and he would proceed on across the field. In the old way the pickers climb over several rows to unload into crates in the drive. This damaged the vines, reduced the later settings of melons, and wasted the picker's time.

Much seed is sprouted before planting but care must be taken not to start long sprouts. The seed are put in a sack, soaked about 12 hours, flattened out not over an inch thick so they won't overheat, and buried in sand. They sprout in two or three days, depending on the heat, and must be planted at once. The field is harrowed two or three times before the plants are up.

Seeds are planted by machine thickly in drills six feet apart. If plants are very thick, they are thinned with a hoe as soon as they come up; but later if not so thick. The final thinning comes about June 1, when the vines average a foot long, showing which are strongest. These are left as nearly as convenient three feet apart.

If continued cultivation does not keep the vines growing, they need water. This is given through a furrow in each center. Plenty of time is allowed for a thorough soaking, but no water is allowed to touch the plants, because that would bake the soil around them. Several rows may be irrigated at once with a small stream. Within two or three days the ground is cultivated. One such irrigation and two cultivations may be given before the vines run into the way.

Growing Plants in Hot-beds.—Some growers think that growing plants in hot-beds to get a good stand is worth while. In one case there were only forty hills missed in more than six acres. Thrifty growth was made and some plants in bloom while plants from seed on the same ground were just coming up from planting on the same date. Small pasteboard folding cases were used to grow the plants in and the case removed when the plant was in place, just before filling in around it.

Pruning for Early Fruit.—J. E. Johnson, of Los Angeles county, believes he can ripen cantaloups a week or ten days earlier by pruning. He prunes the tips off with a corn knife when the vines are five or six joints long. This makes them throw earlier laterals which bear fruit. When the laterals have grown a joint or two beyond the fruit of the first crop which will already have set, he prunes off their tips with a quick sweep of the corn knife around the hill. It does not pay to prune for the second crop, which would have to compete with the general first-crop run from unpruned fields.

Cantaloups in Young Orchard.—H. S. Reed, of Imperial, thinks cantaloups are one of the very best summer intercrops. They shade the ground, and the frequent irrigation they require is good also for the trees. He took off 228 crates of cantaloups per acre when the trees were one and two years old, and followed them with a winter crop of Bermuda onions. Of these he got 240 crates per acre, which sold at $1.40 to $1.55 per crate. The winter crop would be feasible many years, but summer crops would soon suffer from too much shade from the growing trees.

How to Tell a Ripe Cantaloup.—The fruit is ripe for shipping when there are cracks about the base of the stem, which comes off with a little pressure of the thumb, leaving a smooth "cup" in the melon. If too green, sharp pieces of the stem will remain in the cup. The netting on an unripe melon is flattened, but when it has sugared up and ripened enough the netting will be full rounded clear up to the stem if there is any netting that far.

Varieties.—The wonderful advancement of the cantaloup as a commercial product has quickened effort for new varieties and given new incentive to sharp selection to secure characters likely to facilitate long shipment or to increase the demand. Relatively small size, symmetrical form, thickness of flesh and reduction of the seed-cavity, durability, flavor and color of flesh are among the improvements which have been diligently sought. Each year brings forward something new and worthy of trial to determine local behavior and suitability. Obviously a book which aims to be useful for a number of years after its publication cannot satisfactorily serve as a guide to choice of varieties which are constantly changing. Annual catalogues of California seedsmen should be carefully consulted and promising novelties should be tried on a small scale.

Rocky Ford: The variety upon which the Colorado cantaloup industry was established and it sustains the same relation to the commercial product of California; developed by selection from the old "Netted Gem"; slightly oval, finely netted, average weight 1½ pounds; flesh green, thick and very sweet. Continued selection is being practiced upon this variety and "Netted Rock" has been favored in this state on the claim of heavy bearing and greater average production of standard melons. In the Turlock district "Pollock's 25 Rust Resistant" is chiefly grown. This is also grown in Imperial valley with "Yellow Pink" and "Greenflesh" also in favor, which are standard varieties in the valley.

Burrell's Gem: Larger than Rocky Ford; flesh reddish and of different flavor; an improved Paul Rose, which it has largely displaced.

Hoodoo: slightly flatter than Rocky Ford but otherwise similar; flesh reddish.

Large Yellow: an old variety, large oblong, slightly ribbed and coarsely netted; flesh light, yellowish green; quality excellent; still popular though very different from modern commercial types.

California Large Nutmeg: an old variety still popular in local markets and good for shipping; large, rough, netted skin; flesh thick, solid, dark green; flavor delicate.

Monteral Improved Green Nutmeg: large, slightly flattened at the poles, densely netted skin, flesh thick and of good flavor.

Early Hackensack: large size, productive, excellent flavor.

Large Hackensack: large size, roundish, very prolific, thick, juicy flesh, rich in flavor.

Tip Top: nearly round, lightly ribbed and netted, skin light and flesh deep yellow.

The small, early varieties, like Jenny Lind, are not largely grown, as the trade prefers the large nutmeg varieties. The small varieties are, however, very desirable for home use.

CASSABAS OR WINTER CANTALOUPS.

One of the most interesting and promising phases of melon growing in California is the advancement of the "winter melon," comprising several types, of which the first to reach California was the Cassaba or pineapple melon which was introduced in two varieties: one by the late General Bidwell, of Chico, in 1869, and another by the late Dr. J. D. B. Stillman in 1878. Of these the latter has secured the greater popularity. Later introductions and selections and probably hybridizations also, have brought half a dozen quite distinct varieties into notice and a considerable product has been secured both for local sale and distant shipment during the late autumn and early winter. Which varieties will survive cannot be told and in this line California seedsmen's catalogues must be consulted each year. Mr. H. T. Musser, of Los Angeles, is the best informed Californian on this group of melons. On irrigated lands in frostless places these melons can be sown in mid-summer and find ample autumn heat and freedom from frost to reach perfection. The ripe fruit remains in good condition for months without cold storage. They can be stored in the shade of a shed. Even if the exterior becomes ill-looking the flesh remains sound usually.

Though these winter melons can be grown wherever other melons succeed, the chief commercial product comes from the Dinuba district on the east side of the San Joaquin valley and from Los Angeles and Orange counties. They are usually planted later than summer cantaloups, say in May and June, and are given a little wider spacing.

The Golden Beauty and Winter Pineapple are late varieties which may be kept in storage until February. These do not mature as early as the hybrids with the summer cantaloups of which there are a number. The Honey Dew is getting famous for fine grain and good flavor. Good eating condition in cassabas is shown by slight yielding under thumb pressure.

THE WATERMELON.

The watermelon is more strictly a warm region plant than the muskmelon. It reaches great size and sweetness in interior regions of highest heat, coming nearer to the coast in southern California than in the upper part of the state. The heat is, however, high enough in some of the coast valleys and foothills, which are in some part separated from the coast by high ranges, to produce a very good watermelon.

The gratefulness of the interior climate of California to the watermelon is seen in the way the plants volunteer wherever on cultivated land a melon may have gone to decay. In cultivated orchard they may almost be called weeds, though sometimes the volunteer crop is turned to account. A case is cited where watermelons were planted between the trees in a young orchard. After the melons were harvested, and before the volunteer crop appeared the following year, the ground was plowed twice, harrowed twice, and cultivated four times in the regular course of orchard work. Notwithstanding all this disturbance of the soil, the seeds, which remained in the ground during the warm rains of winter and spring, did not sprout until June—considerably later than seed sown that year, and produced as good a crop as the latter. Being, probably, deeply covered they awaited the penetration of the warmth, which came first to the seed sown near the surface. The soil was a light loam, naturally well drained, and the seed abided its time in good condition.

Soils.—Soils which best suit the watermelon are warm alluvial soils, and the plant thrives on a lighter, drier soil than suits the muskmelon. It does well on a light soil with a retentive sub-soil, which acts as a reservoir of moisture. In such a case the surface soil may be coarse or even gravelly. Good specimens have been shown which have been grown without irrigation on recent deposits of mining detritus; on the other hand, good melons are grown on rather stiff clay loam. On heavy land much is gained by plowing under a winter-grown sod or green crop, or a covering of manure, which renders the soil more permeable as well as enriches it. The plant seems to tolerate many conditions, but neither cold nor wet agrees with it.

Culture.—The preparation of land for watermelons is like that for cantaloups, already described. In regions of heavy rainfall the fall plowing should be done with enough dead furrows to remove surplus water so that the spring plowing may not be delayed by wetness. Two spring plowings and pulverizations are desirable on the heavier soils.

Firming the seed-bed below the plant is very important so that moisture may rise to it from the subsoil. This is done by following the January or February plowing with a disc with the plates set straight and weighted with sand bags to make them cut deep and to close all underground openings. This is done twice in winter and is followed through the spring with spiketooth harrows and weed cutters, often alternately, to make a fine mulch about three inches deep over the firm capillary seed-bed, soil from which will ball in the hand, while without this sub-surface packing, the soil will be dry all the way down. If the soil is sandy and inclined to blow the surface must not be made too fine. Wind damage can be reduced by sowing rye in strips about forty feet apart—planting four rows of melons between them. Such protection from cold winds may bring ripe melons a week earlier. The rye strips make driveways for picking. They should be plowed up, when the rye ripens in May, to check evaporation. The melon roots extend into the rye ground if it is not allowed to dry out too much.

Irrigation.—Watermelons root deeply and on deep open soils free from plow-pan or hard-pan will supply themselves with moisture from below if the soil preparation has been of the right kind and the rainfall adequate. If not, irrigation must be employed in good soaking amounts, on light soil which takes them well, and not too frequently.

The land is laid off with a marker in eight or ten feet squares or six by eight and eight by ten feet, and planted, after danger from frost is over and the ground is warm, with 10 or 12 seeds in a place to cover accidents and insects. These are reduced at the first hoeing to one or two plants in a place. The cultivator should be used as soon as possible to prevent crusting of the soil, and cultivation should be kept up until it interferes too much with the growth of the vines. During the first two months of their growth the cultivator is almost constantly running in the melon field.

Time of planting is, of course, dependent upon the frost record of the locality. To get the earliest melons, growers often take the chance of replanting by planting in March if it is an early spring and the soil is in good condition. In light interior soils the most of the planting is done in April, and in frosty situations early in May. For succession, planting can proceed on moist or irrigated land until July, and in frostless locations July planting will give ripe melons as late as New Year's.

Harvesting.—When early sowings succeed, melons can be had in June in the interior, but the weight of the crop comes in July or August. An average yield in field culture is one carload, or one hundred dozen melons to the acre. Sizes run from a common merchantable size of 20 pounds up to a monster of 131¾ pounds, grown in Los Angeles county many years ago. Melons of 90 to 100 pounds have been reported from all regions which make any pretentions to greatness in this line.

When is a Watermelon Ripe?—Various tests are proposed. One is the color of the curling tendril on the vine opposite the stem. When this becomes brown and hard the melon is ripe. The same is said to be the case when the white under-color becomes yellowish. But we have the assurance of commercial growers that by thumping a melon or looking at the curl anybody stands a good chance to pick it green, except after it is dead ripe, which is too late to ship it. But when you slap a ripe melon with the open hand, or catch it as it is tossed from man to man by car loaders, if it springs under the hand it is ripe. If it is hard and does not give, it is green. If it gives out a dead, hollow sound, it is dead ripe. Most of the varieties turn a lighter color when ripe and develop irregular, slight creasing of the rind.

Stock Melons.—Excess crop or defective watermelons and cantaloups are freely used for stock feeding. There is also especially grown for stock the pie-melon or citron-melon, which is sometimes called a "citron." This word should, however, never be used in this state without the suffix "melon," because the citron is an ancient and honorable citrus fruit, which we are growing on trees. The name of this fruit was probably connected with a melon because in cold countries they make a preserve of the rind which has a fancied resemblance to the citron of commerce which is made of the skin of the fruit.

Citron melons are of low nutritive value but serve a good purpose. In one hundred pounds of them there are 0.7 of one pound of digestible protein, 3.3 pounds of digestible carbohydrates and 0.2 pound fat, which, giving a true value to the fat, means 4.5 pounds of nutrients. Alfalfa hay contains approximately 53 pounds of nutrients to the one hundred pounds, counting the fat in the same way, making the alfalfa about twelve times as good, weight for weight. However, an added benefit to the citron melons comes in the fact that they are a succulent food and have an excellent physiological effect aside merely from the food content. This succulency makes it very good with alfalfa hay or bean straw, with which it makes a balanced ration. Rotten melons are, however, dangerous to stock. Probably much of the evil attributed to melons is due to this fact.

Watermelon Varieties.—Everything offered by seedsmen in the form of an improved watermelon is quickly put into California soil. The result is that in the state as a whole very many varieties are grown, probably as many as of any single garden plant. Still, a few varieties are easily leading in popularity. The following have commended themselves to California growers:

Angeleno: believed to be of California origin; dark green, roundish, bright red flesh, thin rind; excellent shipper and largely grown. Seed must be soaked to close cracks before planting. Standard variety white seeded but selections with black and brown seeds are being introduced; long bearer, apt to be busy until frost.

Florida Favorite: large, oblong, deep green, mottled; good flavor and a good midseason variety and a good shipper.

Fordhook Early: very early, medium size, globular, tough, deep mottled green rind, red flesh; good for early shipping.

Cuban Queen: large, symmetrical, solid, rind thin and strong, striped with dark and light green, flesh red, tender and very sweet, vine very strong in growth and productive. Melons keep well and ship well.

Kolb Gem: round, dark green, with light green stripes, which are narrow and of dull color, fair size, flesh bright red and good flavor, tough rind and a good shipper.

Iceberg: like Kolb Gem, but darker green and flesh deep red; a good shipper.

Southern Rattlesnake: oblong, light green, beautifully striped, thin rind, flesh scarlet, solid and very sweet.

Lodi: large, solid, light green, flesh deep red, rich and delicious, and extending to within half an inch of the rind. For many years this variety almost controlled California markets but is now but little grown.

Chilian: oblong, deep green, mottled and striped, flesh bright red, sweet and high quality; good for home use because of thin, brittle rind.

Kleckley Sweet: medium sized, oval, dark green, flesh bright red, high quality, largely grown for home use and shipping.

Ice Cream: very large, long, solid deep green, flesh yellow.

Excel: newly introduced and making a record for size and large yield, both in southern and central California, and promising for long shipment; early ripening.

Tom Watson: dark green mottled; oblong, flesh scarlet, thick core; apt to be over-large; rather late.

Klondike: high quality, thin rind and very tender flesh; chiefly grown in southern California and very popular in local trade, also held to be a good shipper; very small seed.

CHAPTER XXV.

THE ONION FAMILY.

ONION.—*Allium cepa.*

French, ognon; German, zwiebel; Dutch, uijen; Danish, voglog; Italian, cipolla; Spanish, cebolla; Portuguese, cebola.

LEEK.—*Allium porrum.*

French, poireau; German, lauch; Dutch, prei; Danish, porre; Italian, porro; Spanish, puerro; Portuguese, alho porro.

GARLIC.—*Allium sativum.*

French, ail; German, knoblauch; Dutch, knoflook; Danish, hvidlog; Italian, aglio; Spanish, ajo; Portuguese, alho.

CHIVES.—*Allium schoenoprasum.*

French, ciboulette, civette; German, schnittlauch; Dutch, bieslook; Italian, cipollina; Spanish, cebollino.

CIBOULE.—*Allium fistulosum.*

French, ciboule; German, schnitt-zwiebel; Dutch, bieslook; Danish, purlog; Italian, cipolleta; Spanish, cebolleta; Portuguese, cebolinah.

SHALLOT.—*Allium ascalonicum.*

French, échalote; German, schalotte; Dutch, sjalot; Danish, skalottelog; Italian, scalogno; Spanish, chalote; Portuguese, echalota.

The onion is another of the great vegetables in California—great in the size of the tubers and in the crop, great also in the ease with which a constant supply of fresh onions can be secured throughout the year in the open air; greater still, perhaps, in the fact that the superb local conditions for onion-seed growing have given California almost the monopoly of the onion-seed trade of the United States, and we have sometimes produced more seed than could be sold with profit to the growers. Though the local consumption of onions, in proportion to the population, is large, and though there is an export trade in all directions, there is now and then an over-production and a reaction even to scarcity, so that the market price is subject to wide fluctuations. A more trustworthy demand would develop a producing capacity which has thus far hardly been entered upon although during recent years distant shipment of onions has notably increased. And yet this is a matter in which great expectations may not be realized. In 1917, because of a great shipping demand owing to a partial failure of the eastern crop of 1916 and to great exhortation to produce war foods, California onion acreage was increased to 13,000 acres against 6100 acres in 1916. From an extreme high of $12 per ctl. in March, 1917, the price broke to $0.75 in July and much disappointment resulted. Even without war issues onions are subject to wide fluctuation as the price per ctl. in San Francisco for each month for the decade 1907 to 1916 shows, as follows:

Month	Average Low	Average High	Actual Low	Actual High
January	$1.14	$1.37	$0.40	$2.60
February	1.64	1.93	.50	3.50
March	1.73	2.02	.50	3.40
April	2.03	2.80	.50	4.00
May	2.00	2.83	.50	5.00
June	1.22	1.90	.60	3.75
July	1.24	1.65	.25	4.25
August	.98	1.14	.35	2.60
September	.84	.97	.40	2.50
October	.84	.98	.40	2.00
November	1.08	1.19	.40	3.00
December	1.19	1.42	.25	3.25

Though wide fluctuations and producing dangers are thus shown, well planned enterprise to produce early onions to fill out the eastern spring supply is warranted in places where the crop comes early. About 1000 carloads of the Bermuda type of onions are annually shipped to interstate markets, principally from Coachella and Imperial valleys. These onions move from April to July. The total onion product of the state for the last few years has been about 3,500,000 bushels from about 8000 acres.

Though local conditions are favorable, and almost incredible returns are sometimes secured, onion growing is exacting in its requirements in California, as everywhere, and the crop is one which no one should undertake without adequate resources of energy, patience, promptness and elasticity—either in his back or in his pocketbook. No matter how well suited his soil, or how good his stand of young plants upon it, a few days' neglect may put them out of sight in a forest of weeds, from which they cannot be profitably rescued. Still, to the diligent grower who can command suitable soil and the labor needed at a certain time, and is prompt and persistent in the use of it, there is always the promise of as fair a crop as man needs to see, for the climate not only favors growth, maturing and harvesting, but it gives the plant freedom from many pests and diseases, which are grievous in other countries.

Situations and Soils.—The onion is profited by a long growing season. It grows most luxuriantly and its bulb expands most freely in a moderate temperature and with a good moisture supply. It endures heat well, if moisture is ample; it is easily forced into maturity by drought, and though it is fortunate in some respects, that the bulb has the power to renew its growth and reach full size with the renewal of moisture, this is little consolation to the grower who aimed at a crop of marketable onions, not of onion sets. It is important, then, that the growth of the plant be not arrested in this way, and, to assure this, moisture must be adequate until satisfactory size is attained. Land naturally moist, or in which a good supply may be retained by cultivation, or for which irrigation is available to counteract natural tendency to dryness, is necessary for the full success of the onion as a mature crop. In the winter, if rains are up to the average, very good growth of green onions can be had on land which is too dry in summer to carry the bulb to full-sized maturity. For satisfactory summer finishing of the crop, soils which are prone to dry out must be avoided, unless irrigation is available. How this matter is affected by methods of propagation will appear presently.

If the needed moisture can be afforded, onions can be well grown on a variety of soils. Quite heavy adobe can be made to do, but it will be at the cost of much thorough cultivation, producing tilth which is difficult and expensive to attain on such soil. Every addition of sand or silt to the adobe improves it in this respect, and the ideal soil for the onion is one which is retentive enough under cultivation to keep the plant roots from a touch of drought, and friable enough to be easy in cultivation and easy also for the expanding bulb to displace as it grows. The bulb should expand on the ground surface, not under it, and it is very difficult to secure this on a clay without baking of the surface, which dries the roots and results in prematurity and small size in the bulb. On the other hand, sandy soil is usable only at a cost of frequent irrigation, for it also loses surface moisture in spite of stirring. Besides suitable mechanical condition of the soil, it is essential that it shall be rich in plant food. Onions resent a poor soil. Fortunately California has large areas of loam, of mixed peat and sediment, and of alluvial soils, which are so rich that many onion crops can be grown without fertilizing, but in garden work the free use of manure is the secret of quick, tender and large size, both in the green and mature onion. But the use of fresh manure just before planting is not desirable, and even well-rotted manure should be applied several months in advance of planting, that it may become thoroughly incorporated with the soil.

The great onion regions of the state are the lower stretches of the rich coast valley, the moist river lands in the interior, and the winter crop in the so-called "desert" lands of the Coachella and Imperial valleys, where the crop is grown by irrigation. Otherwise onions are grown largely by rainfall and natural seepage. Fine onions are also grown on upland loams, with or without irrigation, according to local climatic conditions. All these classes of lands occur in large areas throughout the state.

Propagation of the Onion.—The onion is grown here, as elsewhere, by three main lines of propagation: from seed sown in the field, from transplanting seedlings and from sets. The last is by far the least important in California, and the choice between the other two depends upon the special end in view, as will appear in the discussion of them.

The Crop from Seed.—In this case the growth is to be pushed continuously on the same ground from seed to sack. The main crop is grown in this way, and for this method California has manifest advantage in its long growing season. The winter-grown crop for early spring and early summer sale is started in October and November on land deeply moistened by irrigation or fall rains, and for the fall or main crop seed may be sown as early as February for the onion is hardy against our valley frosts. The winter-started crop on retentive soils is carried through with moisture held by summer cultivation, or on coarser soils by irrigation and cultivation, until the bulbs reach as large a size as is desirable for marketing.

For seed-sowing the land should be as deeply and thoroughly prepared as has already been prescribed for sugar beets. The work should begin with fall plowing to open the surface for absorption of rainfall, to be followed later by a deep cross-plowing to fully turn in the crop of weeds and grass which will come with moisture. After that a shallow plowing or cultivation may be given to kill later growth of weeds and to contribute to surface pulverization. The seed should be sown when the advance of the season warms the soil. The precise date depends upon two considerations: first, the local rainfall, and second, the local weed growth. Where spring rains are usually light, earlier sowing is best; where spring rains are usually generous and where weed growth is great, it is often wise to defer sowing and use the cultivator for weed-killing, so that the ground may be as clean as possible before the seed is sown. Weeding onions is one of the most expensive and tiresome of all field practices, and it is good policy, where moisture is ample, to sow much later in the spring for the advantage of securing cleaner land, as well as to prevent the growth of "thick-necks" or scallions, which, though edible, are not good keepers and do not sell well. Each locality has its own policy in sowing onions, which can be learned by conference with experienced growers.

When the sowing time comes be sure the land is fined well. Use nothing but the freshest seed from responsible dealers; mark out a straight line for beginning and sow the seed with a seeder with a guide so that the straightness of the first row may be followed in the others. If the rows begin to vary from this, strike another straight line and proceed again from this. Distance between the rows depends upon the method of cultivation to be adopted; some are grown with two feet distance and horse cultivation is used, but most growers choose a distance of twelve to sixteen inches and use hand cultivation. The hand hoes, or cultivators with wheels, work very easily and rapidly in light soils. Care must be taken to work them deeply enough to produce a good soil mulch.

Depth of covering depends upon season, moisture and character of soil, as explained in Chapter XI. With onions the depth would vary from one-half an inch on heavy soil to one inch on light, or slightly more on light soil in a dry locality, is about the range. The seeder should be set to drop the seeds about three-quarters of an inch apart in the drill, which will use from four to five pounds to the acre. After sowing, the ground can be firmed in any of the ways mentioned in Chapter XI. A light roller is most expeditious and satisfactory if the soil is in the right condition of moisture.

Onion seed is sometimes rather slow in starting and the cultivation should not wait until the plants appear. Mr. S. J. Murdock, of Orange county, shows how skillfully the hand wheel hoe can be used in the onion field:

> After seeding, thorough, shallow cultivation is essential. Do not wait until the plants are up before beginning; from four to eight days will be proper, or when the seed begins to show signs of germinating, which can be ascertained by carefully brushing the soil from the drill row. I put the curved hoes on my wheel hoe, with the straight ends of the hoes pointing inwards and lapping about two inches and hoe right over the rows but not deep enough to disturb the seed. It saves a great amount of hand-weeding by killing the weeds just starting to grow in the rows. As soon as the onions are up sufficiently to follow the rows, I reverse my hoes, with the curved ends next to the rows, just far enough apart so as to hoe as close as possible without cutting the young plants by running the hoes astride the rows. This operation hoes both sides of the row at one trip of the machine. Follow this by hand-weeding; this operation is best performed by the crawling process, that is, by getting down on hands and knees astride of a row and pulling every weed in sight, and loosening the soil around and between the plants. Repeat this as often as any weeds are to be found, and under no circumstances allow the weeds to grow above the onions; at the same time keep the wheel hoe at work between the rows and as close as possible.

It is desirable to use plenty of seed in field sowing. Sometimes it is possible to make something from the young onions while thinning the plants to about four inches apart to the rows, but usually the thinning is done before the plants get the proper size for "top onions."

As previously said, the bulb of the onion should be at the ground surface, and the dirt should not be thrown to any extent on the onions by cultivation. The roots should be well covered, but not the bulb. Practically all onions are grown by flat cultivation. Even when started in furrow banks, etc., the soil is usually leveled by subsequent cultivation.

Transplanted Onions.—Next to growth from the seed, the transplanting of small seedlings from the seed-bed to the field, is most practiced in California. This method has recently been proclaimed in the Eastern and Southern States as a "new onion culture," but it is really an old practice in the south of Europe, and has been followed in California for a third of a century or more in preference to starting from onion sets. It is a fact that transplanting produces more uniformly large onions than growth from the seed in place, and the crop also reaches maturity sooner, as the transplanting does not sacrifice the time gained by the earlier start in the seed-bed. Employing these two points of advantage in a region suitable to quick winter growth, a very early crop of mature onions is secured, which sometimes strikes a bare market and is very profitable, while the regular crop, coming in later, may be worth much less.

Seedlings for transplanting are grown in California in the open air, according to the conditions for germination described in Chapter XI. Where there is likelihood of heavy rains the raised bed described in Chapter VIII is a safeguard, but where the soil naturally drains well, or where rain is light, such arrangement is not necessary. Nor is it necessary that the culture should be very deep. The seed is started in the fall, when the rate of evaporation is reduced. Shallow culture promotes early growth and, if the soil has been previously deeply moistened, there is no need of such deep work as would be desirable if the plant was to pursue its full course in that place.

Some growers use a little bottom heat by covering in fresh horse manure with the plow and shallow working the surface into fine tilth. This practice is not essential. It is best suited to heavy soil and ample moisture; it has an element of danger on light soil with scant moisture. The seed is sown at different times in different localities from September to November—the early date in northern California, for the rains come earlier, the weather is cooler and the plants of slower growth. In the south a later start agrees better with the rainfall, and more rapid growth brings the seedlings to planting-size in less time.

In the seed-bed the seed is usually thickly sown broadcast, lightly covered and rolled or pressed down. The surface is protected from drying and from packing by heavy rain, with a light mulch of fine manure, covered with boards until the shoots appear, or covered with a single thickness of old sacking until the shoots begin to pierce it. Any device which keeps the surface moist and loose is applicable. The plants usually reach a height of six or eight inches at time for transplanting.

Transplanting.—Transplanted onions are usually grown on lighter soils than those from seed because the crop is to mature earlier and is not so dependent upon moisture retention. Again the lighter, warmer soils give the most rapid winter growth, as already stated. Preparation of the land is the same as for seed sowing and the transplanting is done at about the same time of the year—from February onward, according to local climate and soil conditions. The plants are pulled, if the seed-bed is sandy, and they lift easily, or lifted with a shovel and separated. The top and roots are shortened about half the length of each, and the plants, dropped along the rows by boys, are set, with the finger or dibble, three inches apart in rows twelve inches distant, pressing the soil firmly around the plant. Planting can be done by line or by indicating it with a roller encircled by rope at proper distance or by marking out shallow furrows with the hand wheel hoe, etc. The lines must be straight for ease and efficiency of subsequent cultivation, which must be clean and thorough.

The cost of growing seedlings and transplanting is more than field seed-sowing, possibly about $25 per acre, but the weeding and cultivation of the former is less. If there is no particular rush about earliness, transplanting can be done after the most of the season's weed-starting is over. Some growers count this quite a gain. Transplanted onions will bottom more uniformly and give a better stand.

Growing from Sets.—There are at least three kinds of onion sets: "top sets" or buttons which form on the seed stem in the place of the seed, according to variety; "bottom sets," which are either small bulbs from thickly sown seed, prematurely ripened, or small bulbs which form beside the old bulbs in some varieties. In California the varieties which habitually produce top or bottom sets in connection with stem or bulb (the so-called "tree onion" and "potato onion"), are not grown to any extent. They are inferior to other varieties which are satisfactory in this climate. All onion sets have the habit of proceeding with their enlargement when placed in moist ground, but some growers find that the bottom sets from seed are more likely to run to seed than top sets from the seed stem. Mr. Adams, of Potter valley, was in the habit of growing his own top sets in this way:

> Plant the onions of the variety which produces top sets in the place of seed, eight or ten inches apart, with rows two feet apart; cultivate well and gather the sets when the seed-stalks are ripe or perfectly yellow. Let the sets get well dried, then store in a cool, dry place six or eight inches deep on a board floor and cover with clean, dry straw. Never put them in sacks, boxes or barrels, as they will most surely mold.
>
> In growing onions from these top sets, I plant them as early in February as the ground is suitable, on the richest of my land; make the rows perfectly straight by using a strong garden line; make rows one foot apart; press the sets firmly into the mellow soil nearly or quite out of sight, placing them an inch or so apart. When they are nicely up, a good top dressing of fine, dry, decomposed hen manure sown broadcast and well hoed in, is most excellent, especially just before a warm rain. A few weeks later a light dressing of ground bone, or unleached ashes, will forward them wonderfully, and in a short time you will have onions fit for an epicure. Thin out as wanted for use, leaving space enough for those that remain to mature for winter use, or for the purpose of raising top sets for another year.

To keep sets or old onions from going to seed when started to grow; whenever a seed stem appears with pointed bud on top, cut it off close to the ground. The same onion never sends up two seed stems; and if the sets have plenty of moisture, they will make big onions in the usual way after the seed stem is gone. Otherwise, they would all go to seed with no onion left at the bottom. The sprouted onions will (if the seed stems are kept cut out) make quite a quantity of smaller onions that are fair size to use, and keep well when stored for home use.

The foregoing is obviously for garden, not for field practice. In fact, for field work, sets of any kind are not used to any extent in California.

Bottom sets from seed are grown by sowing the seed thickly, allowing the plants to grow without thinning, and to mature by the drying on the ground, when about the size of marbles. These are then pulled, dried thoroughly on the surface of the ground and are then stored in a cool, dry place until planted.

Growing sets in California for planters in distant states is largely undertaken in Orange county, and one grower, G. A. Murdock, shipped one hundred and forty tons from thirty-five acres in 1910. The sowing is timed to get a succession in the product. The early varieties, in 1911, began to be sown February 9th. Sometimes the crop goes in as early as December and January. Following these comes the New Queen variety, which is followed by the Brown Australian. The planting continues till June and the harvest of the late sown comes in the fall. The early sets are ready for shipment in June and July, and go mainly to Texas and Georgia. The handling of this business is described in this way:

> In preparing the sets for shipment the crop is first pulled and spread on racks prepared for that purpose, to be dried in the sun for three to five weeks. From the field the trays are hauled to the packing-house, where they are dumped into the hopper of a large circular separator, run by machinery, in which the tops are beaten off. In another machine, to which the onions and chaff are conveyed by an endless belt, the chaff is blown out. Thence the elevator takes the onions to the grading machine, which separates them into four classes according to size, and from which another elevator carries them upstairs, where a final sorting takes place. Here is a long row of machines before each of which an operator sits to inspect the sets as they pass along the carriage, while the defective sets are cast out. This double sorting ensures a high grade product. From here the onions drop back to the ground floor, where they are sacked and crated for shipment. The average per acre is close to four and one-half tons, while six and seven are frequent.

Irrigation of Onions.—Though our onion crops are largely grown without irrigation, it is often desirable to use water to carry the summer growth to satisfactory size on coarse soils prone to dry out. Water can be applied by any of the methods described in the chapter on irrigation. Enough water should be used to secure thrifty, but not excessive growth, and stirring of the ground after irrigation should only be delayed long enough to bring the soil into proper working condition.

Sometimes transplanting is done in connection with irrigation. The plants are properly trimmed and placed in the trenches alongside the irrigating furrows, on a slant to keep the tops from the wet ground (made so by applying the water). They will readily take root, when they may be straightened up by the hoe. Sometimes the water may be passed through the trenches, when the plants may be put in place by hand when the soil is in proper condition.

A field of peas for canning near Los Angeles with pickers in the distance.—Page 229.

Photo Sacramento Co. Supervisors

A glimpse at the heart of a California pepper plant.—Page 234.

Harvesting Onions.—In the maturing of the crop and the harvesting California has great advantage in a warm, dry summer and early fall. Mr. Murdock, of Orange county, gives these suggestions on harvesting:

> When the tops have turned yellow and dried or shriveled up near the bulbs, and the majority have fallen over, the crop is ripe and ready to harvest. If on moist land they should be harvested at once, for if left long in the ground the moisture from below and heavy fogs of the coast region will soon cause them to start new roots, also a new growth of top, which would soon spoil the whole crop. On dry land, however, the summer crops can remain quite a while without injury.
>
> Harvesting is done by pulling two or more rows; lay the onions next to the standing rows, and when across the plot, turn round and pull a like number of rows and lay with the ones previously pulled. This leaves them in a continuous pile across the field for topping, which is generally done with a sharp knife after the onions have laid a few days to more fully mature. While topping, the bulbs are usually thrown in heaps ready for market or to store away, as the grower may determine. It is best to sack or haul from the field while the sun shines, as the onions should be perfectly dry in either case.

A Sacramento valley grower turns down the tops when they become limp and when they are pretty dry the onions are pulled by hand, cultivation having kept the ground soft. They are left in fifty to sixty pound piles to cure until the tops are perfectly dry. If the sun is very hot, protect the onions in the piles by keeping the tops over them.

Yield.—Ten tons per acre is a fair yield on good soil, well handled, but this amount is frequently exceeded and even 30 tons has been secured, according to credible testimony.

Garden Culture of Onions.—Garden culture proceeds upon about the same lines as field work, and by methods already described. Due regard should be had for succession, and by proper use of water in summer and of ridge or raised bed in early winter, it is practicable to have crisp, young onions all the year, and mature ones with but a very short season of storage. Onions have been matured from seed sown every month of the year, but the ripening was not reached every month because progress is slower at one time than at another.

In the garden onions should have most generous treatment for delicate flavor and crispness depends upon quick growth. The use of fertilizers in preparation of the soil, and of liquid manure during growth, are strong helps toward this. The onion accepts gratefully the richest manures.

The first top-onions in the fall can be grown by using bottom sets planted closely in the row just as soon as the ground is well moistened by early rains. The succession can be had by sowing seed at intervals, beginning at the same time the sets are put in and continued when the ground is in good condition until spring.

The following method of growing sets for garden use is approved by the experience of Mr. F. Austin, of San Diego county, who grows fine vegetables for the love of it: Sow the seed in the spring, say March, not later than April, then as the plants develop in the drills which have been sown not too thick, and begin to assume size and form of bulb, at both sides of the row begin to remove the earth with the hoe, the object being to retard the growth or top and form a "set" below. This is repeated, going along each side of the growing onions, removing the dirt and even cutting some of the roots a second time. The tops begin to wither but the bulb increases in size until finally you run the hoe entirely under the roots severing them and leaving the now new-formed "sets" to dry for a few days, when you take them by the handful from the row and shake off the dirt and put them away under cover from sun in a cool place until, say, October. Then plant these "sets" and they will grow to onions fast and in advance of anything you can get from seed and give you large juicy onions.

Rotation.—The advantage of clean land for onions has been mentioned. This is often best secured by allowing onions to follow carrots or potatoes or corn. The cultivation of these vegetables sprouts and kills many weeds, which are more easily handled in connection with those crops than with the onions. The cultivation also renders the soil more friable, which is a prime requisite to the growth of onions.

Intercropping.—Large quantities of onions are grown in strawberry regions, being irrigated incidentally in connection with the berries. The strawberry plants are on ridges in rows eighteen or twenty inches apart; the onion row between the strawberry rows parallel thereto in the center of the ridge, the ridges being also eighteen to twenty inches apart, so the water runs down between the ridges. Onions are also grown between the trees in young orchards on rich, deep, moist, or irrigated land. This cannot be long continued to advantage, as onions do not take kindly to shade, but delight in full sunshine.

Varieties.—Out of the multitude of varieties a few have proved most serviceable and satisfactory for California conditions:

Barletta: very early, small, pure white, smooth and handsome; largely grown for pickling, also for early top onions in garden culture.

California Early Red: very early, large size, flattish, mild flavor; not a good keeper. Chiefly grown by Italian market gardeners and the variety probably was introduced from Italy.

New Queen or Pearl: small, early white, fine flavor. Chiefly grown for pickling and for top onions.

Silver Skin or White Portugal: silvery white, medium size, excellent flavor and esteemed for table use. Small bulbs largely used for pickling.

Southport White Globe: leading variety in Los Angeles market; silvery white, wax-like; young onions very handsome; mature bulbs keep well.

Prize-Taker or Spanish King: very large and beautiful, rich straw color, flesh white, sweet and tender; productive and keeps well.

Australian Brown: flat, light brown, a long keeper and good shipper; very productive on rich sandy soil with ample moisture. A leading commercial variety.

White Bermuda: yellowish white, flat, very early, chiefly grown in southern California for early shipment.

Red Bermuda: resembles White Bermuda, except in color.

Yellow Flat Danvers: most popular flat yellow variety, very hardy and trustworthy cropper, leads in San Francisco where it is apt to be called "silver-skin."

Yellow Globe Danvers: large, round, yields well and keeps well; solid and good flavor. One of the main varieties in all parts of California.

Red Wethersfield: large, round, slightly flattened, deep red with white flesh, strongly flavored, well adapted for low, moist soils, hardy. This and Danvers Globe constitute a main part of the California product.

Crystal Wax: medium size, waxy white, flat, good for winter crop from fall seeding in interior valleys.

White Queen: very early, good garden variety but not large nor good keeper.

Mammoth Silver King: large, flat, white, mild flavor, garden variety.

Ailsa Craig: said to be largest onion grown; early, good flavor and fine grained.

Tree-onion: a variety which produces top-sets instead of seed at the head of the seed stem. Used in garden culture as already described. It serves a good purpose under certain conditions, but is very little used in this state.

THE LEEK.

California produces large quantities of leek seed for distant sale, but the leek itself is but little grown in California, except by market gardeners, and its use is chiefly by citizens of foreign birth, although it is gaining in popularity. The edible part is the blanched lower leaves of the plant. The culture is at first practically the same as that described for transplanted onions, except that the young leek plant is deeply set in a depression in friable soil, and as it grows the earth is drawn about the leaves, which are tightly sheathed together so as to blanch them into the appearance of a thick white stem. Thus the later cultivation of the plant resembles that of celery. It is handiest in the garden to sow the seed in drills one foot apart, at intervals from fall to spring, so as to have a succession, and plant the seedlings when about the diameter of a goose quill, in the bottom of a drill or furrow several inches deep. The plants need wide spacing, say six to ten inches, for they reach considerable thickness and make a large display of leaves. Cultivation gradually levels the ground. Leeks need ample moisture and good cultivation to attain fine size and tenderness. If the blanching is not particularly cared for, the plants may be grown at the surface just as onions are, except for the greater distance the plant requires to develop. The leeks chiefly grown in California are the Large American Flag, of good, uniform size, and strong growth, and London Flag, a large, strong grower also.

GARLIC.

What is said of the restricted local use of the leek applies also to the garlic. It is grown with about the same cultivation as the onion, and the planting season is of the same duration. The method is by planting the bulblets, or "cloves," taken out of the silvery skin which covers the bunch, and planted like onion sets about six inches apart in rows one foot distant from each other. It may also be grown by planting whole cases of sets one foot apart in the rows. The planting should be rather shallow and the soil should be light and well cultivated to allow the free expansion of the bulb.

There was a great rush for garlic after the European war opened. Purchases for shipment covered the local supply and prices to restore it ran very high—even to $15 and $20 per ctl. Stimulated production soon became unprofitable, and the field for enterprise in garlic seems to be strictly limited. Some Californians coming from less favored countries are surprised to find their garlic bulbs flowering freely and wonder if the bulb is valueless after that, as is the case of onions going to seed. Apprehension is unnecessary. The garlic is a true perennial and will keep on making bulblets while the onion is short-lived and must come again from the seed more quickly.

CHIVES.

These are small plants, whose leaves have the onion flavor desired in cookery. They are grown from the small bulbs, and from thick clumps or an edging for permanent garden beds. The leaves are shorn off whenever desired and are most excellent for giving a mild onion flavor to salads and soups.

CIBOULE.

Another plant used like chives, but of taller growth, is the Welch onion, or ciboule. It makes no bulb, but seeds freely, and the plant develops rapidly to cutting condition. The cultivation is the same as of onions grown from seed.

SHALLOT.

Both the bulbs and leaves of this plant are used to give the onion flavor in cookery. Propagation is the same as that of chives, by means of the small bulbs, and the culture is the same as of onions grown from sets.

CHAPTER XXVI.

PEAS.

The Garden Pea.—*Pisum sativum.*

French, pois à écosser; German, schal-erbsen; Dutch, doperwten; Danish, skaloerte; Italian, piselli da sgranare; Spanish, guisantes para desgranar; Portuguese, ervilhas de grao.

The Lentil.—*Lens esculenta.*

French, lentille; German, linse; Dutch, linze; Danish, lindse; Italian, lente; Spanish, lenteja; Portuguese, lentilha.

The Garbanzo or Chick Pea.—*Cicer arietinum.*

French, pois chiche; German, kicher-erbse; Italian, cece; Spanish, garbanzos; Portuguese, chicaro.

Dry heat is offensive to the pea, and its occurrence imposes the chief limitation to the success of this vegetable in California. The escape from this limitation consists in winter growth, as far as practicable, and in recourse to the coast region where atmospheric humidity is greatest and summer heat least. The pea is very hardy against frost, and this advantage goes far to compensate for its susceptibility to drought, because it enables it to thrive in the winter in the very places where it perishes in summer. The obvious deduction is that in regions dependent upon rainfall the garden planting of the pea must be as early in the fall as adequate moisture has reached the soil, and in regions where irrigation is available, it is desirable that the start should be made in advance of rainfall for the earliest product, and that other plantings follow for a successsion, until it is ascertained what is the latest date of sowing which will reach satisfactory maturity. If practice proceed upon this basis, the pea will be seen to have a much longer season than in wintry climates, although, in some places, midsummer growth is impracticable. Most failures to realize this satisfaction with the pea are due to late planting and failure to recognize that, in many parts of the state, the pea is a winter and not a summer plant.

In the growth of field peas most disappointments have followed the same misapprehension, and a monopoly of pea conditions has been conceded to the coast when the interior really can grow large amounts of forage, at least, by taking a different time of the year for it. Fortunately, this fact is coming to be better understood, and large fields of peas are now grown as winter feed for dairy cows and in the orchard to be plowed under early in the spring for green manuring, where only recently the pea was supposed to be unsuited to the climate. These remarks apply to the true pea, not to the so-called "cow pea," which really belongs to the bean family and is very susceptible to frost injury.

Soils and Situations for the Pea.—The pea succeeds on a wide variety of soils—a good, rich loam of sufficient retentiveness being the ideal. Where it is winter-grown, with moderate heat and ample moisture, lighter soils can be successfully used, because they are warmer and dispose of the surplus water more readily. Though the pea withstands much frost, it needs warmth for rapid advancement, and for this reason the earliest peas, as, for example, peas for Christmas from September sowing, are grown where there is little frost, and hillsides are often used to escape the heavier frosts of the valley below. In moist bottom lands in the interior, and on uplands near the coast, peas naturally thrive much later in the season than on the interior plains and hillsides, and the latest green peas are grown in the moist lands of the coast valleys, moisture being retained by cultivation or supplied by irrigation, according to local conditions. By using these different situations green peas are available for city trade nearly the entire year.

Culture.—From what has been said it may be inferred that the pea at different times of the year is to be handled with all the arts for releasing or retaining moisture, which are described in the chapters on the planting season, drainage and cultivation. The reader should study these, and choose the methods adapted to the soil and time of the year with which he expects to operate. Depth of planting is also governed by these factors, as described in the chapter on propagation. The pea will thrive with deep covering, according to the soil and moisture—even to covering the seed in a plow furrow in a light soil—but in a heavier soil, with assurance of moisture, a single inch of depth may best favor its growth. Deep working of the soil is also, as a rule, acceptable to the pea and where the crop is to come late and to endure a measure of heat and drought, deep working in preparation and fine surface cultivation, as late as feasible without injury to the vines, is necessary. But, on the other hand, for fall and winter growth in some situations and soils, such thorough work may not be called for. For winter work, too, it is not desirable that the surface should be worked to a fine mulch; surplus water is relieved by evaporation and the surface is prevented from crusting, if a coarser condition is retained. The pea plant gives every possible advantage to the grower; it is strong growing and hardy, and it has a large seed which makes a vigorous shoot. If the grower can give it escape from dry heat it will serve him well both in garden and field.

It should be remembered, however, that the pea needs a certain amount of heat, though it be small, and there is nothing gained by sowing in cold, wet ground. In small, frosty valleys with heavy rainfall sowing should often be delayed until the ground is warmed in February, though on slopes above such valleys much earlier work can often be done satisfactorily. The fitness of certain varieties for seasonal conditions will be considered presently.

For the Earliest Peas.—The earliest peas, counting the first of July as the beginning of the California season, are in picking condition in December, from seed sown in August and September. Irrigate the land thoroughly, plow well, harrow, and sow the seed with a drill as nearly as practicable an inch apart in rows two and a half feet distant. Another way is to open a shallow furrow with a single plow, scatter the seed in the furrow and cover with a cultivator, covering the seed and stirring the space between the rows. In growing peas on hillsides for very early market, the foreigners, who are the chief growers, depend much upon hand work and bring the rows nearer together. Irrigation must be used from time to time to keep the soil from drying until the rains come and subsequently if the rains are light. The plants must be pushed to bring well-filled pods and continual moisture is essential. Cultivation, to keep the soil clean and mellow, is necessary. A light harrow can be safely used with peas even after the plants appear. After this the free use of the cultivator will be found profitable.

Peas in the garden are often successfully grown in hills about three feet apart with about a dozen peas in a hill. Where there is apt to be much winter water and the soil heavy, a raised bed is desirable.

Later Sowing.—Whether it will be profitable to arrange for a succession of peas in the early winter depends upon the local soil and climate. On light soils and in regions of moderate rainfall and frost it is quite feasible, but in most regions December and January bring the lowest temperatures and the longest rainstorms of the year, and the ground is out of condition. The advent of February changes things enough to meet the requirements of the pea, and then the sowing for the spring and summer succession may begin. At first the ridge or raised bed method will give safety against excessive water, but later sowings should be made for flat culture on soil most thoroughly prepared and well cultivated afterward.

Field Growth.—Where peas are sown for forage or for a crop of dry peas, sowing can be done broadcast on land which has been previously plowed and harrowed, and then the seed is covered with a shallow cross-plowing of the whole field. If the soil is friable and a good condition of moisture, this leaves the surface well loosened and able to receive considerable rain without baking. This method answers well on light soils in the interior early in the winter, and the moist condition of the upper coast valleys is also satisfactory. In the upper coast valleys peas can be safely sown as late as May for summer crop and forage. Wherever heat or drought and hard ground are likely to be encountered before the vines cover the ground, drill culture and cultivation are better.

Peas in the Orchard.—It has already been mentioned that the winter growth of peas in the orchard for plowing under for green manure, is being widely practiced in this state. The pea has the power of appropriating atmospheric nitrogen and its growth in the winter in the warmer parts of the state may be effected with little loss of moisture to the trees. Growing the pea crop in the orchard to be gathered green for canners' use has also been successfully done in this state, when the trees are small. The pea is probably one of the least injurious of the inter-cultures and under certain conditions may be of actual benefit to the trees. For this purpose the crop should be gathered and the green vine plowed in as early as possible.

No Support for Peas.—Peas are chiefly grown as a prostrate crop in California both in garden and field. The preference is for the dwarf or medium high kinds and they are allowed to stand or mat down as they see fit. It better suits a climate where reclining on the ground very rarely induces mildew and where the covering of the ground assists in maintaining the coolness and moisture of soil which delights the pea.

Varieties.—Of the two main divisions of pea varieties, the smooth and the wrinkled skins, the smooth are the more hardy and can be safely grown early. The smooth pea may resist decay and grow where the wrinkled seed will perish. And yet the wrinkled pea is so popular that wrinkled varieties have almost excluded the smooth kinds from growth as vegetables. Our enterprising seedsmen are continually offering new varieties, but the older sorts still prevail largely, as follows:

Alaska: tall-growing, small smooth pea, pod short, well filled; very early.

American Wonder: dwarf, wrinkled, very compact growth, productive and early, fine quality, very sweet; the leading early pea in California.

McLean's Little Gem: dwarf, wrinkled, very early, productive, rich and sweet.

Nott's Excelsior: resembles American Wonder; larger growing and more productive; fine quality; long bearing period; excellent home garden pea.

Gradus: earliest of its height; pods large; peas delicious.

Premium Gem: an improved Little Gem with larger pods; popular for home gardens.

Yorkshire Hero (also called Alameda Sweet): later than dwarf varieties; most popular in all parts of the state for main crop; strong grower, with branching habit; large pods well filled with large, wrinkled peas; keeps in condition on vine longer than other varieties.

Stratagem: strong grower, with large showy pods; peas large, of good flavor.

Champion of England: well-known late variety, largely used by canners.

Telephone: late, very productive, large pods; peas sugary; largely grown and sometimes very profitable. Dwarf Telephone or Daisy is the same variety of low growth.

Edible Pod or Sugar Peas.—Although California interest is almost wholly centered in the shelling varieties of peas, there has recently been some attention paid in home gardens to the edible pod varieties which are used in the kitchen as are string or snap beans. They are available because of their hardiness at times of the year when string beans can only be had from frostless regions if at all. Their culture is the same as for other kinds of peas.

LENTILS.

Though of another botanical genus, lentils are best classed with peas. They are quite hardy and make a good winter growth. Lentils are a kind of pea which Americans have little use for and our seedsmen do not usually find it desirable to offer the seeds, which indicates a minimum demand. They are grown just like a dwarf pea. They have a pea's endurance of frost and are planted from fall to spring for cultivation like peas. Lentils are rarely seen in California, probably because peas are preferred, not only because of flavor, but because of more easy handling. The lentil bears but two seeds in a pod. It is like the garbanzo in that kind of shiftlessness. Americans like peas which put eight or ten peas in a pod and make the pod big enough to grab easily. Besides, the lentil is not eaten as we eat peas: it is used only in stews and soups and for that purpose we use "split peas," which are cheaper because more easily secured in quantity and suit our taste just as well. One certainly should not undertake lentils extensively unless he can get a contract with a buyer who has a good European appetite. Owing to their early winter growth they may come into use here for cattle food as in Europe.

GARBANZOS.

Another two-seeded pod bearer is the garbanzo or chick pea, which is a hairy plant of the vetch family. Its uses are like those of lentils, but it has also served widely as a coffee substitute. Its culture is easy, like the pea in method, but the product is always used dry or mature. The plant is more hardy against drought than the peas. Its production in California is small, but seems to be increasing. The price is uncertain: one must find some one to contract for them. They are not much used by Americans. Money has been made in the past by shipping them to Mexico, and there is demand for them in places where Mexicans congregate in this state. Garbanzos are not beans, and will not sell for beans. They are near-peas. They are in their manner of growth and their uses more like lentils, but in their appearance more like a lop-sided pea.

CHAPTER XXVII.

PEPPERS.

CHILE PEPPERS.—*Capsicum annuum.*

French, piment; German, pfeffer; Dutch, Spaansche peper; Italian, peperone; Spanish, pimiento; Portuguese, pimento.

The settlement of California by people of Spanish birth or descent naturally brought the pepper into early prominence in this state, and the considerable fraction of our population which now traces to south of Europe nations serves to hold the plant in popularity. American citizens have also wide liking for the pepper in some of its uses, and the result is, large local demand for the capsules both in green and mature states. There is this main division in the demand,—the northern races prefer the large, green, mild varieties; the southern races chiefly use that which is ripe, red, and fiery in flavor. But, of course, this distinction is not to be pushed too far. Each kind has its uses which are observed by all consumers. In the California markets the two kinds or conditions stand side by side in such quantities as to make them conspicuous.

Though the pepper is usually an annual, it carries its profitable productive life into the second year in the thermal regions of the state. The stem has a tendency to become woody and after a period of partial dormancy, it sends out new shoots and bears its second crop. This cannot, however, be expected in a frosty location.

Garden Culture.—Peppers are usually grown from plants started early by artificial heat in the same manner indicated for eggplant. Planting out should be done after danger of frost is over and the soil is well warmed by the sun. Later plants may be grown by planting the seed in drills in the open ground, thinning the plants afterward to suitable distance. Moisture should be evenly maintained by cultivation or irrigation as needed, but excessive water is undesirable at all times from the seed sowing onward. The plants will endure heat and drouth, but the fruiting is deficient in size and quantity, and for the best success, especially with the large varieties, rich, light soil, well cultivated and adequately moist, is a requisite. The distance between the plants depends upon method of cultivation. In the hand-worked garden, the plants may be set a foot apart in rows, eighteen inches distant from each other, but usually greater distance is better, and for horse work the rows should be two or three feet apart.

Field Culture.—Field culture for canning and for the trade in dried peppers is pursued on a large scale in southern California, especially in Orange county, on the deep loams of the gentle slope oceanward. An outline of methods is prepared from data furnished by Mr. Allan Knapp, of Anaheim, who is widely acquainted with local experience in the pepper district of Orange county, which is credited with a product of about a thousand tons of dried peppers a year.

Seed.—It is exceedingly important to have a good type of plant, and this can be secured by selecting pods in the field, to furnish seed for the following year, from low bushy vines full of pods of medium length. A tall bush will not produce as many pods and it is more liable to be broken by strong winds when loaded with fruit. Besides the end of the pods from a low plant will rest on the ground, and in that position they will prop up the branches, providing you keep crowding a little earth to the row at each cultivation, as will be described later.

When these seed pods are gathered put them on a string and hang up to dry against the south end of a building. Do not put them into the evaporator when hotter than 110 to 115°. They may stand more heat, but perhaps only 50% of the seed may germinate quickly, and the other half may delay a week longer than those dried in the sun; neither will it make so strong a plant.

Growing Seedlings.—Select a location for the seed-bed where good drainage may be had. Sandy soil is best, but not so poor that it contains no plant food to nourish the young plant. Plow and level the plot, harrowing or raking with a hand rake, as only a small piece of land is used; sow seed about March 15 in rows three inches apart, covering one-quarter of an inch. On this spread one-quarter inch with sand. Start your seed beside a large tree, if you have one, and you will have fair success. The tree will drain your land. If the young plants begin to die by "damping off," take a trowel and dig out the affected spots and throw them away. The plants should have five or six leaves on before transplanting commences. Wet the soil of the seed-bed thoroughly before lifting the plants, as the roots are damaged less.

Field Planting.—Plow the field deeply early in the winter and keep down weeds by shallow cultivation until planting time, when danger of frost is past. The chile plant is very sensitive to cold. May 1 is a good time for planting. Mark field off in rows 4½ feet apart and set 2½ feet apart in rows. Should the weather be dry and irrigation necessary plow a furrow beside each mark and run water in these furrows before and after planting, and if the weather be very hot two or three irrigations may be necessary to start plants. Always allow 24 hours after irrigating before plants are set, unless soil is very sandy. Then work may commence sooner.

When through with the irrigation furrows, plow back and cultivate the land until level as before. Keep soil in good growing condition always. When plants are 12 to 15 inches high use a ridger (such as is used in raising levees for irrigation checks) with plenty of space open behind and straddle each row, thus drawing the earth to each side of plant and giving it support. Water may be run down these rows at this time. As plants grow make the ridge wider with a crowder run in between each row. This ridge will keep plants from breaking down so readily when laden with fruit, and when fruit strikes the ground it will not decay so readily because the ridge will be dry. Do not make your first ridging too high, and do not do the work too late; if so, the first setting will be greatly injured by pushing the earth against the fruit, thus leaving no room for it to grow, and many pods will be curly and eaten by bugs.

Growing from Seed in Place.—Allen Brothers, of Garden Grove, formerly grew plants in hot-beds but later have used a garden drill to put the seed in finely pulverized ground in the field where they will grow without transplanting. This is usually done in the first half of March. The rows are 3½ to 4 feet apart and the seeds are sown thick enough so that they will leave a good stand when thinned to 20 inches apart at 3 to 6 inches high. The ones thinned out may be transplanted as late as June to places where there are not enough already. But little water is necessary in transplanting and there is but little loss. Considerable dirt may be taken up with the plant, as it is usually moved only a few feet at most.

Shovel cultivators are used after each irrigation on the harder lumpy soils, but harrows are sufficient on the sandy soils. Always bear in mind that peppers have a widespread root system near the surface, and these roots should not be cut. The same thing is to be remembered in ditching for irrigation. Broad flat ditches are right, between low ridges along the rows to keep the water away from the plants.

Irrigation.—Irrigation is the most particular need of peppers; they require more than other crops. Allen Brothers irrigate ten to fifteen times per season, according to the soil. From July 15 when the fruit begins to set, the vines need water about every ten days.

Directly after an irrigation about September 15, burr clover is sown for fertilizer, and a last shallow cultivation is immediately given. The clover is, of course, to keep up the fertility. The Allens have raised peppers three or four years in succession on the same fields; but they usually alternate with lima beans, which also build up fertility.

Gathering and Curing.—During September the fruit will begin to ripen, the time of ripening depending upon the soil and the care of the crop. In sandy soil the fruit will ripen quicker than in deep sediment. If the plants lack moisture they will ripen much faster, which looks well, but they should be kept green as long as possible. It pays better in the end.

The crop should be picked as each setting ripens; go over the field three or four times. A pod should be left on the vine until of a dark red and it has lost its hardness, being somewhat pliable. Have the crop gathered in large baskets, but they should be hauled in boxes rather than sacks, as they are less liable to be bruised, and a bruised pod is liable to decay unless dried at once. If peppers are to be dried on strings, have them dumped on a table or on the ground, as you prefer. Allow 24 to 48 hours for stems to wilt after gathering before they are put on the string. This work is done by running a twine through the stem of each chile, the twine to be 10½ to 11 feet, and same may be hung on a scaffold to dry or put into especially made evaporators. Some growers report favorably on drying their crop on trays instead of on twine. During recent years most of the drying has been done by evaporators, which is accomplished by artificial heat in six or eight days.

If an early frost should catch the plants pick off all the fruit both ripe and green. If spread on trays in a dry, cool place much of the green fruit will ripen.

Soils for the Commercial Crop.—Although peppers can be successfully grown in any good garden soil, it is important for the field crop to choose deep, rich, sandy loam, or sediment soil, which will not bake very rapidly. The young plants must be set in damp soil and if land should easily bake it will become hard and will dry out more readily about the young plant and the growth will be very slow. It is not wise to grow more than two crops of peppers on even the best of soils without fertilizing very liberally. Cover crops plowed under are found very profitable.

The Crop for Canning and Drying.—At Garden Grove in Orange county in 1914 Allen Brothers, who grew forty of the estimated 750 acres in Orange county and give the following outline of the product, sold both green for canning and dried for other uses. The yield of green peppers has never been less than five tons per acre and has been as high as fifteen tons, averaging about nine tons green besides the ones left to ripen. Very many growers contract their crops to the canners early in the season.

Green peppers which are not suitable for the canneries or which are missed by the pickers during the short time they are good for canning, are allowed to ripen and are then artificially dried. If all are allowed to ripen, the dried crop is 1500 to 3000 pounds per acre and they sell at seven to nineteen cents per pound, averaging about ten cents. Often the crop is sold green and less than 500 pounds per acre are dried. A large part of this 500 pounds is that part of the crop which is green when frost kills the plants in November to February. They are dried on trays and sold at ¾ cents to be ground up for chicken feed.

When the whole crop is dried they are hung up in a shed over dry or steam heat five to seven days. The old custom of drying them in the sun is not now common because many of the ripe peppers rot before they dry that way. Some of them are ready to pick November 1, and were picked one season for drying until February 15, which is exceptional.

In the sheltered foothills, they pick green ones all the year around. In the level country about Los Angeles, green peppers are picked for the canneries from about August 15 till frost. Each pepper is suitable for picking only a short time, not over two weeks, and is in best condition just before it begins to turn red. None should be overlooked early in the season, for the more you pick, the more blossoms will come and new ones be set.

Varieties.—The varieties chiefly grown for home use and marketing green are Large Bell or Bull-nose, an early variety of mild flavor, fruit large, slightly tapering and generally terminating in four obtuse, cone-like points. It is a favorite sort, both for pickling and for table use. Sweet Mountain is another popular variety similar to the foregoing, but larger and milder in flavor, and Chinese Giant is an immense pepper, often twice as large as Large Bell. Recently the Pimiento has been gaining rapidly in popularity for beauty, mild flavor and desirability for canning.

The standard for hot pepper and for the dried crop is the Mexican chile, long, narrow pods on a low-growing, narrow-leaved plant. One type is a very dark, thick-meated, cone-shaped chile, growing form 4 to 6 inches long, which is gaining ground; while the Long Red, or Anaheim chile, having pods from 6 to 10 inches long, is the best known. The plant is strong and holds its fruit up well and is very productive. There is also a longer variety with pods up to fourteen inches in length, which, however, is claimed to be less productive and light when dried, though the flesh is quite thick when green.

CHAPTER XXVIII.

POTATOES.

THE POTATO.—*Solanum tuberosum.*

French, pomme de terre; German, kartoffel; Dutch, aardappel; Danish, jordepeeren; Italian, patata; Spanish and Portuguese, patatas.

THE SWEET POTATO.—*Convolvulus batatas.*

French, patate douce; Italian, patata; Spanish and Portuguese, batata.

Potatoes may be grown everywhere in California without irrigation, except on strictly arid plains and deserts, and it needs but slight watering to enable the light but rich soils of the arid regions to surpass the naturally moist lands both in the size and quality of their produce. Some of the grandest potatoes ever grown in the state have been taken from light, warm soils whose natural growth was sagebrush and other desert flora. The superiority of the higher, lighter lands, either with adequate rainfall or irrigation, to the moist lowlands of the interior river bottoms or the coast valleys, have been clearly recognized during recent years. In the earlier days, the coast and interior river bottoms were supposed to be, *par excellence,* the potato regions, and their products were transported great distances to interior uplands which were thought to be unfit for the plant. Now the choicest potatoes are grown in these places and the production in the older regions has decreased, though the potato still constitutes an important crop. The present situation is, that the potato fields may be seen everywhere from the skirts of the cliffs which look down upon the ocean, along the bottoms and sides of the coast valleys, on the reclaimed lands and benches of the great interior rivers, up the slopes of the foothills and in the mountain valleys of the Sierra Nevada and out beyond, upon the stretches of sagebrush, wherever water can be had to turn the desert into a garden. California has a capacity for potato production beyond the ability of any available market to handle, and though a few years ago it seemed likely that our climatic advantages in early production would give us command of distant consumption at certain times of the year, it has since been shown that much less can be profitably done in this direction than was anticipated. There have been in some years very large shipments at reduced freight rates when the eastern production was deficient, but the potato is ordinarily too cheap an article to endure the cost of long transportation. In 1916 California was eighth in the rank of the United States in potato production, with 10,575,000 bushels grown on 75,000 acres, with a farm value for the crop of $14,805,000. The production was about the same as during the preceding five years but the valuation was nearly doubled by war prices. The record yield of the state is held by the Boa Vista ranch of El Dorado county, where a selected acre produced 47,254 pounds of merchantable potatoes and 2559 pounds of culls and received the award by the State Horticultural Commission in 1915.

Situations.—Though, as has been stated, the potato grows wherever adequate moisture is assured, there is much difference in the times of the year at which maturity is attained. Though the potato is a tender plant it will endure light frosts, nor does it always yield its life when the frost blights the foliage. Dormant buds lower on the stem develop into a new top growth. It is, therefore, possible to secure fall and even winter growth in places where a strictly tender plant like the bean would perish. Where only light frosts occur and where irrigation is provided to supplement rainfall, it is possible to have new potatoes all the year and to bring to edible condition three crops successively on the same ground within a twelve month, though it is, of course, better to let the potato take its place in a rotation.

New Potatoes.—The first new potatoes from a California point of view, would be the crop that comes with the first green peas, counting July 1 as the beginning of the year. In fact, in the San Francisco district, the first potatoes and peas come from the same localities. They make their growth in the fall from planting on ground well soaked by irrigation in July and August. The regions for this work are those in which fall frosts are light or do not occur at all—the thermal belts at different elevations on the hillsides both on the Coast Range and the Sierra Nevada, also on the warm interior plains of the Sacramento and San Joaquin valleys, but not usually on the river bottoms of large valleys nor on the low places in small valleys. Owing, however, to the partial resistance to frost of the potato, there are very wide areas both on the coast and in the interior of central and southern California, where the fall growth of potatoes is safe and worth wider attention than is given to it. Where irrigation may be had to start the seed well the fall rains usually carry on the growth.

Fall Crop in the Valley Garden.—Starting potatoes in the autumn in the interior valley has some difficulties. Old seed from cold storage rots badly when transferred to the soil under a July and August sun, and new crop seed may lie long dormant or rot also. A plan which works well in small plantings for home use is described by W. T. Kirkman, of Merced, in this way:

> I conceived the idea of sprouting the potatoes and transplanting somewhat after the manner of sweet potato planting. I procured a quantity of well-matured small Early Rose potatoes. I spread them in a plant shed, one and two layers deep and covered with two or three inches of sand. One part I covered with sawdust (old chaff will do). I kept this bed well watered by using the sprinkler on it daily. In three or four weeks sprouts began to appear. These I extracted carefully with the parent potato attached and planted at once. I went through this bed at intervals of a week apart, four times. For each of these plantings I had to flood a strip three or four days in advance, and

as soon as the ground was broken and hoed, the plants were set by line and the ground firmed at base around the tubers by hand. They were inserted about five inches deep, the tops in most cases being covered loosely. On good potato land, this flooding and plowing when the ground is fully damp and yet in good pulverizing order and followed by a good shallow cultivation, insures moisture for a crop.

Later New Potatoes.—Planting for what may be called the second run of new potatoes requires stricter attention to thermal conditions. This crop must be growing in December and January, which are our months of heaviest frosts and rainfall usually. Strictly thermal belts, to be found at different elevations on hillsides, generally within the reach of ocean influences in the south half of the California coast line, but also here and there on the hillsides of the interior, favor the growth of the potato all through the winter, if the soil be light and kept warm by free escape of surplus water and abundant winter sunshine.

The third run of new potatoes is secured by the planting of the early varieties as soon as possible after the heaviest frosts of the locality are over, and the soil becomes warm enough to push growth. This is the main potato planting season of California, and covers a wide range of dates, beginning with January on light, well-drained soils at the south to get the earliest new potatoes for eastern shipment in May, of which about a thousand carloads are annually shipped eastward from Orange, Los Angeles and San Bernardino counties. Planting continues in February, not only in the south, but on warm uplands all through the central portion of the state, and later with planting all through March, April and May, as spring conditions come successively to the upper coast valleys and the mountain regions, or as the river lowlands are drained of their surplus water. In fact on interior river lands planting is done as late as June and July and the crop comes on rapidly with ample heat and moisture. In fact on these moist lowlands, planting is proceeding in midsummer on the same fields from which matured potatoes are being harvested from February planting. This, however, though possible, is not good practice usually because the potato likes new land and is advantaged by rotation.

Always New Potatoes.—Thus it appears that potato planting covers the entire year, and that while some parts of the state are digging their main crop, other parts are making their first planting. To bring the matter nearer to a point it may be said that a man in the central coast region may be eating new potatoes from his hillside while he is planting his main crop on his lowlands. And yet one is frequently asked to answer categorically the question: "When do you plant potatoes in California?" Obviously it is a local question, to be learned by experience, observation and inquiry, in accordance with the general conditions outlined in the chapter on the planting season in California. In connection, however, with this wide liberty in planting, taking the state as a whole, it must be borne in mind that local requirements are sometimes very sharp and that planting on the interior plains or in other parts of the state where there is high heat and drought, or the soil becomes dry even with moderate heat, planting must be undertaken early enough to allow a large part of the development of the plant before such stress comes. Local failures with potatoes may, therefore, be often attributed to neglect of planting as soon as moisture and temperature conditions favor growth in each locality.

Soils.—Light, rich loams are best for potatoes as they favor root extension and expansion of tubers and they are retentive enough to hold the moderate amount of moisture which ministers to the highest quality. Very near the coast well-cultivated, light uplands receive atmospheric moisture enough to sustain the deep verdure of the potato fields, while the pastures are sere and yellow. Summer growth on interior plains and foothill slopes and mountain plateaus is sustained by less irrigation than many other crops require, and winter growth, whenever feasible, is best on light, free soils. The sediment and peat of the river lands are also, in their season, light and warm. But the potato insists upon adequate moisture, though its claim is moderate. It cannot give satisfaction unless its moisture requirements are met.

Heavy soils in garden culture can be greatly improved as described in Chapter IV. Early and deep working of the soil and the plowing in of rotten straw and compost and thorough mixture of these materials through the soil will have marked effect, but heavy land potatoes seldom have the beauty and flavor of the product of the light, rich loams.

Fertilizing.—Stable manure may be freely used if applied a few months before planting and worked into the soil when moist enough to promote decomposition. Ten or twelve tons to the acre have been used to advantage. This may be followed by commercial fertilizers just before planting. In the case of the record crop in El Dorado county, previously mentioned, twelve tons of stable manure per acre were spread and plowed in in December. In May the winter growth of green stuff was plowed in and then a ton per acre of commercial fertilizer, analyzing five per cent nitrogen, seven per cent phosphoric acid and eight per cent potash, was disked in and the crop planted.

Culture.—Deep working of the soil is essential in preparation for potatoes as has already been urged for beets and other root crops. The soil must be made mellow to a good depth and kept mellow by subsequent cultivation.

Certified Seed Potatoes.—Assurance of good quality and freedom from disease in seed potatoes can now be had in California by discriminating planters. The state legislature of 1914-15 passed a law known as the California Certified Seed Potato Act, which establishes a standard for good seed potatoes. The administration of this law is in the hands of the State Horticultural Commission at Sacramento, from whom details may be obtained on application.

Seed potatoes to receive certification must be free from the pests and diseases specified in the law cited.

Unless the seed potatoes are old and show active eyes, they should be exposed to the light for about two weeks to advance germination. This is especially the case when the tubers of an early crop are used for later planting the same season or when seed potatoes are taken from cold storage. In that case, vitalize it by exposure to half sunlight for two weeks or more and see that it is disposed to sprout before planting. This is a rational treatment for all potatoes which do not seem to be starting their eyes. In the fresh seed it promotes maturity; in stored seed it determines viability. Never mind if it greens the tuber—that is no objection, though, of course, one does not wish to blister or burn the skin by too much direct sunshine.

All proposed methods of seed-cutting have been tried in California, and each has its advocates. When the soil and season favor, excellent crops are grown from small potatoes used as seed, but commendation of small potatoes for seed does not include the "nuts," which are usually immature, without well developed eyes, etc. Besides, these "nuts" do not have bulk of starch sufficient to strongly start new plants. The smaller potatoes are good for seed providing they have bulk enough and are well matured. They are preferred in planting for second crop in the interior because large potatoes will rot if cut and have too many eyes if not cut. Some growers grow their own seed small purposely by crowding the plants, culture otherwise being as it should be, so that the small potatoes are from good stock and not runts. Generally the selected fair-sized, merchantable potatoes, cut into quarters lengthwise, produce best results. Cutting to single eyes is not a good commercial practice. In certain prize contests, with a maximum of favorable conditions in soil and fertilizing and cultivation, the greatest yields have sometimes been had by single-eye planting. Under ordinary conditions the thriftiest plants come from eyes which started with a good amount of the plant-food stored in the tuber—therefore cutting into two-ounce pieces is commended by some, while most planters do not cut at all, unless the seed tubers are above average size.

When things are otherwise favorable, the size of the crop usually bears relation to the weight of the seed used to the acre—therefore a good weight of seed is a good investment.

There is no advantage in cutting long before planting; there is more danger of injury by fermentation.

Distance between pieces in the furrow depends upon the tendency of the potatoes to grow too large. This is often corrected by dropping more thickly. The range is from twelve to twenty inches usually. It is usual to use from ten to fifteen sacks of potatoes in planting an acre—sometimes even more seed is used.

In the field much planting is done with the plow by dropping the "seed" in every third of fourth furrow so as to bring the roots about three feet apart, and covering with the following furrow. Depth of planting depends upon season and soil as described in Chapter XI; the same principles governing as in the planting of seed. After the seed is plowed in to a depth of four to eight inches, according to season and soil, a thorough cross-harrowing should leave the field in good shape. On light soils disposed to be dry, a light rolling may be beneficial. As soon as the plants appear, harrowing *with* the rows mellows the surface, kills the small weeds, and does not hurt the potatoes. Cultivation between the rows should soon follow and the surface should be kept loose until the plants are quite high. Good, clean culture is the rule with potatoes. In some soils, not disposed to dry out too rapidly nor to crust, crops are often made with little cultivation after weeds stop growing, especially where the plant has the benefit of coast influences, but cultivation for moisture retention, where needed, must be more thorough.

On lands subject to excess of moisture, winter growth of potatoes can be facilitated by the ridge planting described in Chapter VII; but where this is not likely to occur, reasonably flat culture is best, both in winter and summer. Where potatoes are to be irrigated a slight moving of the soil toward the row, so as to make the interspace a little hollow to carry water, is admissible, but "hilling up" must not uncover the firm soil and expose the roots to too great heat and drought. Too high a ridge is also likely to bring the tubers within reach of the moth from whose eggs come the potato worms. During the latter part of the growth the tuber should be well covered with soil.

Irrigation.—The potato should be kept growing thriftily from start to finish. If growth is arrested by drought, a new growth of small potatoes is apt to start upon renewal of moisture, to the detriment of the crop. The aim should be, then, to keep the soil adequately moist until maturity approaches. This is best done by running small streams between the rows, the planting having been arranged for this distribution. As already stated, excessive irrigation is decidedly detrimental to the quality of the crop, and extra effort must be made for even distribution of the water. To allow low places to fill up with water is injurious and to allow the water to come in contact with the plant stems is also dangerous. A good, thorough and uniform wetting of the soil is often enough to finish the crop and it is seldom desirable to irrigate after the bloom appears. Thorough surface cultivation should follow the irrigation, for the reasons stated in the chapter on that subject.

In connection with the irrigation of potatoes it must be borne in mind that many troubles may arise from irregularity in the moisture supply of the growing tuber. Sometimes potatoes are planted on ground which is dry underneath instead of being well wet down either by irrigation or rainfall. Potatoes grow more regularly if they do not have intermittent moisture supply, therefore, it is better to soak the ground before plowing, bringing the crop along that way if possible, or irrigating subsequently as may seem to be necessary, but in no case should the plant be allowed to arrest its growth and start again after irrigation. Of course, when potatoes have stopped growth and are subsequently irrigated, the irrigation cannot cure the trouble, but really increases it, because it causes a second growth to be made. The potato must be kept moving or it will move the wrong way.

Mulching.—For the last twenty-five years the practice of growing potatoes on the interior plains by the help of a straw mulch has been followed to some extent. It has recently been proposed at the East as a new method, but it is really quite old. The seed is plowed in with a shallow furrow so as to cover about three or four inches, then cover the whole surface with partly decayed straw from an old stack or with coarse manure. The mulch will retain moisture enough to mature a crop. There need be no plowing, hoeing, nor weeding, and it is held by those who advocate the method, that the labor of putting on straw is compensated for in the saving of hoeing and weeding. It is also a safe way to grow early potatoes in frosty places because the mulch protects the dormant buds at the base of the stems and new foliage quickly grows if the old is nipped by frost. Potato sprouts are sometimes saved from frost injury by turning light soil over them lightly; subsequently they may be uncovered or allowed to grow through.

Harvesting.—Potato diggers or plows are used to some extent in California, but the common method of gathering is by means of a long-handled shovel which is dexterously pushed beneath the plant so that all the tubers are thrown out at one operation. The yield of potatoes varies from five to nine tons per acre on good soil, properly cultivated.

Storing.—As the summer and fall climate of California is almost rainless and the frosts seldom severe enough to freeze a potato in a sack, the tubers are generally sacked and piled in the field for weeks and months. This advantage is turned by careless growers into a disadvantage, because the potatoes are often seriously injured by heat and light and shriveled by dry, hot winds. Potatoes should be stored in a dark, dry place and screened from access by the moth which lays eggs also on stored potatoes and makes them wormy. If left in the field for a time the piles should be covered with straw or dry tops, thickly enough to exclude the moth.

CHIEF TROUBLES OF THE POTATO GROWER.

The pests and diseases which give the California potato grower most trouble are outlined by the late A. J. Cook as follows:

> There are three fungous diseases that affect the potato, tubers or vines, or both; the common scab, which disfigures the tubers; the rhizoctonia fun-

gus, which affects the vines and roots so that the growing potatoes secure too little nutrition and fail to develop, thus looking like a bunch of grapes, hence the name "little potato." These often appear above ground. The third is the fusarium wilt, which also blights the vines and the roots and later the tubers, which become diseased and are often destroyed.

Scab and rhizoctonia are carried in the soil which has previously borne diseased potatoes, and so contains the germs, ready to inoculate newly planted seed. Both these diseases also carry on affected seed, germs which serve to spread the destruction. These two evils are alike, in that seed affected by either one yields to treatment, if immersed for two hours in corrosive sublimate, 1 to 1000—1 ounce to 8 gallons of water—or in formalin, 1 ounce to 2 gallons of water.

The rough eruptions (scab), so ugly in appearance, quickly reveal the presence of scab. It does not reduce the yield, but so mars the tubers that the price is materially lessened.

The destructive rhizoctonia appears as specks of dirt from the size of a pinhead to quite sizable patches. They are not dirt, however, for washing does not remove them. We can, however, scrape them off with the finger nail without wounding the potato, which we cannot do if the spots are scab. When thus removed the potato is not wounded. Of course, scab, which often resembles rhizoctonia, cannot be removed without breaking the tissue.

The third fungus, worse than rhizoctonia and far worse than scab, is the fusarium wilt. This blights the vine, kills the roots, stops growth and is fatal to the crop. The vines die prematurely, and the potatoes which are not sufficiently diseased to be observed on the exterior surface, will often show the work of the fungus if a slice is cut from the stem end of the tuber. A discolored spot, usually a ring on the cut surface, indicates that the disease is present and that the seed is unfit to plant. The nematode called an eelworm causes a rough, lumpy appearance of the skin and darkens the fleshy part, especially close to the peel. The roughened surface quickly reveals this affection, and eelworm potatoes should never be planted.

The tuber moth bores through the tubers and blackens the tissue. Keep the potatoes well covered with earth during the entire growing season and remove all, even the smallest, from the field as soon as dry after digging. The potatoes should be placed at once in moth-tight sacks, as the moths continue to work after the potatoes are stored, and thus it is imperative to carefully guard against their presence wherever potatoes are stored.

The foregoing troubles are to be avoided by planting healthy seed in clean ground and they are contemplated in the law providing for certification of seed potatoes in the law of 1915, which has been cited. A few other minor troubles may be noted.

Potatoes Going to Tops.—Sometimes potatoes "grow all to tops" and have a great number of diminutive potatoes that also sprout and grow more small potatoes. Excessive top growth is generally due to over-stimulation of the plant during its early life. This may be due to excessive use of stable manure applied too near planting time or to the lack of adaptation of the variety to the local conditions. Where this excessive top growth occurs small potatoes form but are not adequately enlarged by return flow from the top in process of maturing. The reason why these small potatoes take to sprouting instead of enlarging as they ought is due to the fact that the plant starting vigorously with too much moisture became afterward too dry and then starting again caused the small potatoes after becoming abnormally checked in growth to break out with secondary tubers.

Aerial Tubers.—Sometimes tubers appear upon the stems above ground and none are found below ground as they should be. They come about in this way; normally the potato tuber is an enlargement of an underground stem, formed by the action of the return flow of the sap of the plant. The upward flow of sap is largely through ducts in the central parts of the aerial stems. The downward flow of sap, after its elaboration by the leaf-surfaces, is through the tissue which lies just under the skin or bark of the stem and it deposits its burden in the tuber underground. When this tissue is injured in some way so that the return-flow of sap cannot pass along to making tubers underground it goes to work above the injuries and makes tubers in the air. The tubers are simply modified stems either above or below ground, as conditions may determine. Injury to the stem may be mechanical—such as a scrape with the hoe, the work of an insect or a disease. Anything that holds up the sap may do it, if the plant is otherwise vigorous enough for it. Fortunately it is of rare occurrence.

Leaky Potatoes.—Sometimes potatoes go off quickly after sacking and discharge so much liquid that the trouble is called "leak" disease. It is caused by a fungus which exists in the soil and is usually introduced to the potato by a worm in digging. The only remedy so far known for this disease is to prevent the wounding of the tuber if they must be harvested during warm weather. After a severe frost occurs very little trouble is experienced from this disease.

Potato Blights.—It is an interesting fact that the great "potato blight," as the world knows that disease, is not a great trouble of the potato in California—in fact, this disease is largely conditioned upon excessive moisture in the air and that seldom occurs during sufficient duration even in the rainy season except in the upper coast district. When that district was largely producing potatoes there was trouble with "blight," or more properly "late blight," until resistant varieties were introduced. Another disease known as "early blight," appearing in the spring time, is rather more abundant but even that is only active when the air is cool and moist. These blights are manifested by blackening of the top growth of leaf and stem. Wherever these blights occur the treatment is prompt spraying with the Bordeaux mixture as described in Chapter XXXVIII. It should be applied when the new growth is about six inches high and repeated two or three times at intervals of about ten days.

Varieties.—As with other vegetables, California has tried many kinds of potatoes and grows very few on a commercial scale. The first notable varieties were brought from Chile and Peru in very early days, and are still grown to some extent, though the main crop is now made of newer kinds because in some localities the old varieties ran out and showed great susceptibility to blight.

The blight, which was some years ago a serious menace to potato growing, has been largely circumvented by the introduction of new varieties which were thrifty while the old varieties on adjacent ground perished. For this reason new varieties should be tested in all localities.

The potato which constitutes most of the market crop is the Burbank. For mid-season and late potatoes nothing compares with the Burbank. For early potatoes the old Early Rose still prevails widely, though Chili is encroaching upon it in northern and central California. Triumph is a little earlier and is gaining ground. Early White Rose constitutes the greatest part of the southern California crop, and Early Ohio is also popular. American Wonder, British Queen and Pearl are advancing as later varieties.

Although there are local adaptations of different varieties, the character of the potato depends more upon local conditions of soil and climate than upon the variety, and the same variety from different localities commands widely different prices in the market.

SWEET POTATOES.

The sweet potato is grown in nearly all parts of California where rich, sandy loam, suitably moist, can be found. Adequate heat is essential to quality and the upper coast region has localities which are deficient in this respect, but protection from coast influences renders the product satisfactory, even though distance from the ocean be not great. As a rule, however, the crop in the upper half of the state is grown in the interior valleys, while at the south, both the coast slopes and the interior valleys yield a fine product. Where the soil is rich, warm, and free and the moisture sufficient, the sweet potato attains immense size and rightly ranks among the great things of California.

The sweet potato is a strictly tender plant and a heat-lover as well, consequently there is no winter planting, though in drier parts of the state, free from frost, there may be fall plantings which carry their crop well into the winter and for more than half the year fresh potatoes may be taken from the ground, and by proper storing the vegetable may be enjoyed throughout the year.

Preparation of the Ground.—Planting is done at the beginning of the frost-free period and the date depends upon the locality. Usually it comes about the first of May, but preparation of the ground should begin earlier to secure good culture and moisture retention as described for other root crops. In regions of good rainfall moisture enough can thus be retained to make the crop or at least start it will. On dry plains it may be necessary to thoroughly irrigate in the spring before the deep plowing with which the planting is to be made. On loose, lowland soils or in irrigated regions there is often abundant moisture within reach of the plant to serve its purposes and then sweet potatoes may follow a hay or grain crop just as in the practice with common potatoes. Lands which receive enough moisture from below and yet are not wet and cold, produce the crop with least labor and expense, though it is quite feasible to proceed with direct irrigation both for planting and after growth. The sweet potato sends its roots to great distances to find moisture.

Growing the Plants.—The sweet potato grows readily by cuttings from the growing vine planted out directly in the field if the ground is moist and warm. This method is followed to rapidly multiply a rare variety. The usual method is to plant the crop by using sprouts from potatoes on which growth is quickly started with bottom heat. Any of the hot-bed appliances described in the chapter on propagation may be used for this purpose on a small scale, but in the warmer parts of the state it can be done on a large scale for field planting without expense of glass or cloth covering. If, however, the hot-bed is used, care must be taken against overheating.

To grow plants in the open air it is usual to begin in March and dig a trench four or five feet wide and about 18 inches deep; the length according to the number of plants desired. The trench should be dug in light, well-drained soil, in a place protected from cold winds. Put in fresh horse manure and tramp down until about a foot of thickness is secured. Wet it well, but not enough to drain, and immediately cover with three or four inches of sandy soil. Upon this, place the sweet potatoes just as close as they can be put down without touching each other. When done, sift in fine sand between the potatoes and finally cover with four or five inches of very sandy loam, or even with sand. Keep this bed moist but not wet. Moisture and heat may be retained by covering the bed with two inches of loose straw to be removed as the shoots appear. The plants are ready for use in about eight weeks from the bedding of the tubers, when they show a few green leaves; they can be detached by pulling and will bring their outfit of small roots with them as they are pulled out of the sand. The tubers will then send up other shoots which can be planted later.

Rather than begin in March as above stated, some begin as early as February 10 and frame the bed with boards and cover with boards at night to make it safe for the earlier start of plants, which is thus secured.

Some prefer to uncover the potatoes, beginning at one end of the bed, removing the shoots and replacing the covering. This lessens the danger of breaking the shoots. Others split the potatoes lengthwise and plant with the cut side down so that all the shoots come from the upper surface and are thus less liable to break in pulling.

It takes about eight weeks for the plants to grow ready for transplanting, which is done any time up to June 1 with reasonable safety from fall frosts. It takes about 12,400 plants per acre. Each seed potato will produce a first crop of about eight plants and three-fourths as many at later pullings. If only the first pulling is to be used, it is safe to allow 90 or 100 square feet of hot-bed per acre to be planted. This will require about 300 pounds of seed potatoes per acre. Fewer seeds are required if the second and third crops of plants are used, but such plants will produce crops that much later.

Planting.—Most sweet potatoes are grown on ridges about fourteen inches high and three feet apart to secure greater heat in the soil and to facilitate irrigation, but flat culture is also practiced and in some regions is preferred. After the land is well prepared and harrowed down smooth, mark off the rows three feet apart and set the plants eighteen inches apart in the row. When the ground is thoroughly warmed by the advance of the season, say in April or May, take the shoots as described above—trimming the roots to a length of four inches, though some, planting by hand, use long roots. They must, of course, be kept from drying out, the young roots being very tender. In taking them to the field they must, therefore, be kept in a bucket of water, or in a wet sack, the former being the best. Plant out the shoots eighteen inches apart in the rows, one in a place, settling them down in the soil, deep enough to find permanent moisture.

Sometimes when the object is to get unusually large potatoes, instead of pulling off and setting out the slips, the potato is lifted out and with every slip a small piece of the potato is cut out and planted with the slip. This method will bring the earliest potatoes, but the number of sets are many less than though the potato be allowed to remain in bed for their continued production.

Recently a machine has come into use which digs a trench on the top of the ridge and drops water at whatever intervals are desired. Three men, including the driver, transplant two acres per day by machine. The machine opens trenches on two ridges at once, and closes them soon afterward. In the interim the two men sitting on the machine close to the ground, insert plants in the opened trenches about fourteen inches apart, holding them until the machine draws dirt around them. A water tank on the machine automatically wets the plants when set, and is refilled from the irrigation ditch at the end of each row.

Cultivation.—Cultivation for the purpose of weed killing and surface stirring is continued until the vines interfere and after that the vines cover the ground with a thick mat and discourage weed growth.

Irrigation.—The plants are irrigated three or four times per season and cultivated after each except the last, when the vines are in the way. After the vines begin to run, need of irrigation is told by their tips, which show lack of water before any other part of the plant, by drooping. Water is then necessary at once.

Harvesting and Storage.—Use of the sweet potatoes may begin when they attain suitable size, but for keeping they must attain a good degree of maturity, but should not be subjected to frost for it is held that even frosting the vines injures the tubers, and it is advised to cut off the vines just above the ground if digging must be delayed.

The first potatoes to be dug are those which seem most likely to get too large if allowed to mature, according to F. L. Landram, a pioneer sweet potato grower of Merced county. These earliest potatoes are dug in July, though immature, and are generally sold at three or four cents per pound in crates holding a little over 20 pounds each. Later potatoes are sold in 12x12 crates, and those dug after August 1 are packed in standard 100-pound crates 12x16x about 24 inches. They are also marketed in 100-pound sacks.

There are three classes of potatoes: "hog feed" includes very slender potatoes and roots; "seed" or "canning stock" includes those under about 1¼ inches in diameter; salable potatoes are those over 1¼ inches in diameter, though extra large sizes are sometimes discounted.

Some find the keeping of sweet potatoes somewhat difficult. Many pack the potatoes in dry sand and keep them in the house. This is expensive and is not a sure way. Many will rot and sometimes only one-third of them will keep till spring. Storage in the open air with due protection against too great temperature changes and moisture is better. This method has been approved in Fresno county:

> Take stout stakes, say five to six feet long, and drive them into the ground in a row and five feet apart, in some dry place that is not sheltered by trees. Dig the potatoes and throw them up around the stakes to the height of four feet. For a large field a great many such rows may be necessary; for a small patch perhaps one single stake will suffice. When all dug, put four inches of straw as covering. After a week or ten days, according to the weather, the potatoes will have undergone a sweating process. They first cover themselves with moisture, as if they had been dipped in water. This moisture gradually begins to disappear, and as soon as it does so it is time to throw off the straw. This should be done when the wind is blowing; the potato hills should be left open for three or four hours, or until the potatoes appear entirely dry. If the straw covering is taken off in the morning, the potatoes will be dry at noon. Then cover them again with three or four inches of fresh, dry straw, and on top of the straw put three or four inches of soil to keep out the cold. On the top of this must be placed a roof, which is easily made of shakes, nailed to strips of two by three and made in the shape of panels, to allow of easy handling and of repeated use year after year. Potatoes kept in this way will preserve perfectly until next spring. Very few, if any, will be found decayed.

The Season.—Heavy shipping continues from August 1 to January 1, though sweet potatoes are sometimes kept in cellars until April. If growers can get $1 per crate, however, they do not store many. In 1915 the price went down to 50 cents. In 1916 the lowest was about $1.15, and they were selling at $2.50 in mid-February.

Particularly careful handling is required for storage potatoes. The crop ranges from 50 to 125 crates per acre. Fifty crates are held to generally just about pay the cost of production.

For Stock Feeding.—Cull sweet potatoes have been utilized as a hog feed for several years; and experience has shown that at $3.50 a wagon load they are an economical feed. L. D. Collins, of Denair, Stanislaus county, aims to make them available longer by running them through a root-shredder and drying them on fruit trays. In hot or windy weather they dry quickly and can then be stored in sacks. The fruit trays were not altogether satisfactory as they retain moisture; and that tends to rot the potatoes unless the trays are turned. To overcome this Mr. Collins uses wire screen on a frame, allowing the air free circulation all around. The loss in weight in drying is about 60 per cent, depending somewhat on the length of time the potato has been dug. In Mr. Collins' experience in feeding fresh potatoes he has found that his hogs will consume three times as much weight of fresh sweets as they will barley, and do better on them.

Varieties.—Probably all the improved varieties have been introduced in California. The California demand is for a variety which is rather dry and mealy when cooked, although the softer, sweeter sorts have some advocates. The most common variety is called the Californian but it is a Chinese sort introduced in early days. The Southern Queen and the Nansemonds are also popular, and the Jersey Red is grown to some extent in southern California.

CHAPTER XXIX.

RADISHES.

THE RADISH.—*Raphanus sativus.*

French, radis; German, radies; Dutch, radijs; Danish, haverdœdike; Italian, ravanello; Spanish, rabanito; Portuguese, rabao.

HORSE-RADISH.—*Cochlearia Armoracia.*

French, raifort sauvage; German, meerettig; Dutch, peperwortel; Danish, peberrod; Italian, rafano; Spanish, taramago; Portuguese, rabao de cavalho.

The radish is a relish which can be had continuously throughout the year in most parts of California, if proper soil and moisture conditions can be arranged. It is almost a hopeless task to undertake to secure a crisp, delicately flavored radish unless heat and moisture are favorable to quick growth of the plant. It takes some gardening skill, therefore, to produce good radishes in winter localities with sharp frosts and heavy rainfall, while in regions of light frost and light rainfall, winter heat is usually adequate to satisfactory growth.

The best soil for radishes is a rich, sandy loam, though any good garden soil will grow them if a small piece is improved for the purpose as described in Chapter IV.

Preparation of the soil is essentially the same as that already described for other root-crops, and sowing, as already intimated, can be done whenever the soil is in good condition, if irrigation is available for use in the dry season, and there is free drainage in the winter. Temperature is, however, of more moment to the radish than to some other hardy garden plants, and during the colder months, the raised bed, as described in Chapter VII, located on the sunny side of a wind-break, will afford heat enough usually. In other places where cold and rain are greater the "warm heap" described in Chapter XI, may be used. By thus adapting the method to local conditions winter growth can be had anywhere in the valley and foothill regions of the state. Summer growth is mainly a question of soil-moisture which can be regulated by irrigation and cultivation.

As the radish is naturally of quick growth and as crispness and mild flavor are largely conditioned on pushing it to the utmost of its speed, it can be grown to advantage as a catch crop here and there in the garden on ground that is temporarily out of use for a few weeks, or between the rows of more slowly growing vegetables. The gardener should always be ready to scatter good radish seed when he has a little stretch of light, rich, moist soil at command. A little attention and ingenuity will in this way secure a constant supply.

Cooking Radishes.—Mr. Samuel Haigh, of San Jose, reports an experiment with cooking Long Scarlet radishes which he grew as large as carrots, being 1½ inches in diameter and six to eight inches long; solid and crisp, but just beginning to get keen. Peeling removes this, however, making the cooked vegetable very palatable and of an excellent flavor, superior to the common white turnip, which takes much longer to grow.

Varieties.—Popular favor runs in the direction of the turnip-shaped varieties, of which there are very many. The long radishes, like the Long Scarlet, are, however, often chosen for home use. The Icicle is a beautiful long, white variety. The Early Scarlet Turnip is most largely grown and there are several strains of it varying in earliness and color. The French Breakfast, oval, tipped with white, stands next to the Scarlet Turnip sorts. The Italian market gardeners grow what is known as the "Half-Long," a variety of Rose Olive-Shaped and the Black Spanish, very desirable for winter growth. Epicure is small and very quick and beautifully colored red to white. The White Turnip, similar to Scarlet Turnip except in color, is popular with German gardeners, and the Chartier has some popularity as a large scarlet variety, shading to pink and thence to white at the root-tip. The Crimson Giant is very large and generally solid and crisp. The California Mammoth White, introduced by the Chinese, distances all others for size. It is pure white, mild-flavored and crisp, even though it may grow eighteen inches in length and three inches in diameter in six weeks, with interior heat on light soil, abundantly moist. The Long White Japanese or Japanese Summer, is also in the race for size, but is slower in reaching it.

HORSE-RADISH.

Horse-radish is a popular relish in California towns and is bottled on quite a large scale. The plant is easily grown and should be found in every farm garden. A start is most conveniently made by planting root sets. Mr. Ira W. Adams advises planting the roots or sets in rows two feet apart with the sets one foot apart in the rows, and three or four inches under the surface. On rich, moist soil, with the best of cultivation, one can raise roots that will weigh from one-half to three-quarters of a pound. When the roots are dug in the winter for use, break off all the small rootlets from one-quarter to one-half inch in diameter, cut into pieces from three to five inches long, leaving the top end square, and the bottom end slanting, so there will be no mistake in planting them upside down. Tie in small bunches and put into moist sand that has perfect drainage and is exposed to the weather. In very cold, long, heavy rains it is well to cover with shakes, or short pieces of boards. A cool cellar is a good place to store them, but be careful the sand is never allowed to get dry, as the sets will not root nicely without continual moisture. Then during the winter, as the ground becomes warm or early in the spring there will be nicely rooted sets ready for transplanting as before described.

Mr. D. F. Reichard, of Los Angeles county, gives, to the California Cultivator, this advice:

> In planting horse-radish it is advisable to dig a trench or hole and have the plants six to ten inches below the surface, then as they grow carefully fill up to the level. If the soil is light this will not be necessary, as horse-radish will usually come through eight to ten inches of soil. This method of culture produces a long, perfect root. It must be remembered in planting that the old set entirely wastes away and the new plant starts from this set and grows upward, making another large root below the level of the point from which it starts.

Another point of view is presented in this account given by Aggeler & Musser, of Los Angeles:

> The local supply is far below the demand. This condition should not exist, because it is a profitable crop. One grower realized $1100 from two acres. When asked why he discontinued growing it, he replied: "I have not the right soil. It requires a rich, sandy loam, frequent irrigation, but it must be well drained so that the soil does not remain muddy or sour. Then, too, there is so much disease or blight prevalent that one must get a clean start and keep clean by changing places as soon as the soil is infected."

Though it is quite true that one should be somewhat critical about entering upon large commercial production and should not only examine his soil and moisture conditions as above suggested but also should guarantee his product by contracting at least part of it to a pickle maker or other large consumer, no such question should disturb the small grower for he can get good results on any garden soil with very little trouble.

Formerly all horse-radish was of one kind, but the one now in favor in this state is known as the Bohemian—a recent introduction by the U. S. Department of Agriculture. It is a much more rapid grower than the old variety in general use and is, therefore ready for use a great deal earlier. Its large, white roots may be raised in almost any soil. The quality of this horse-radish is said to be far superior to the old variety.

CHAPTER XXX.

RHUBARB.

RHUBARB OR PIE PLANT.—*Rheum sp.*

French, rhubarbe; German and Danish, rhabarber; Dutch, rabarber; Italian, rabarbaro; Spanish and Portuguese, ruibarbo.

Rhubarb attains grand size and quality in California if due attention is paid to the requirements of the plant, and it should have a place in every house garden. It enjoys very rich soil and will thrive on a great variety of soils, even from heavy clay to light peat, providing ample moisture is afforded it. On heavy, retentive soils it must have good cultivation or thick mulching to prevent loss of moisture and surface baking; on light, coarse soils either ample irrigation or natural sub-irrigation will keep the plant thrifty and vigorous. It does not enjoy high heat and drought, and reaches its best estate and is commercially produced in the coast valleys or on river bottom lands of the interior, but it can be very satisfactorily grown for home use on interior plains and mesas providing constant moisture is supplied; partial shade is also grateful to its foliage in the interior, but is not necessary on the coast. Since the wide introduction of winter-growing rhubarb, which defies the frost and enjoys the ample moisture of the rainy season, the range of the plant has vastly increased in California and its commercial importance has greatly advanced.

Culture.—Rhubarb is grown from seed or propagated by division of the roots: the latter insures reproduction of the identical characters of the parent, while from seed there is always a chance of variation.

Rhubarb plants may be grown from seed by preparing the ground in the same way already described for asparagus, and the same care of the seedling as there indicated will bring good, strong rhubarb roots for planting out as yearlings. Mr. Ira W. Adams gives the following special advice for rhubarb seedlings:

> Prepare the bed the same as for asparagus. Sow the seed in rows one foot apart, and one inch apart in the row in a little furrow one inch deep; tramp down lightly with the back of a steel rake and cover with the finest of soil, as the seeds are small and light. When the plants are an inch or two high, they can be transplanted into rows twelve inches apart, and four inches between the plants. By fall they will be fine, strong plants, and can be planted out the next spring in permanent rows.

Root sets are made by dividing the roots of the older plants so that each piece shall have a bud or eye. The most vigorous plants, producing the largest leaves and thickest leaf-stems, should be selected for this purpose.

Potatoes in the Los Molinos region of Tehama County.—Page 239.

New settler's outfit and rhubarb field near Marysville.—Page 256.

Planting.—Before planting either in field or garden the soil should be heavily manured and deeply turned in the fall so as to get the full benefit of the winter rains. Transplanting the old summer varieties should be done when the plant is dormant, the soil in good working condition and warmth enough for growth anticipated. The date will, of course, vary in different localities, but February will usually be satisfactory for the summer growers.

It is best to reset the eyes taken off, as soon as a rain has moistened the ground late in the fall, according to J. B. Mendonca, a large rhubarb grower of Alameda county. This gives them the benefit of all the rest of the rains and makes them ready for early growth in spring.

F. H. Williams, also of Alameda county, in getting sets for replanting, does not dig the roots out, but plows the dirt away from each side of the plant and cuts off the excess eyes with a sharp spade. After this the dirt is plowed back, so the old roots, undisturbed, may send out new feeders into the soft ground without the shock of resetting.

The soil must not be too wet at transplanting or the roots may rot; good warmth and moisture are favorable. The introduction of winter-growing varieties has modified transplanting practice. They are practically evergreen and active except for a short dormancy in the late summer, and, though capable of transplanting by cutting back the leaves all through the rainy season, are usually moved to best advantage from April to June, the latter period being available on irrigated land. A June planting of the winter varieties may yield a good pulling of leaves by Thanksgiving.

There are different ways of planting out, each with its own advocates. Roots set four feet apart each way give good opportunity for cultivation both ways; but some give more room by laying off in six feet rows with the plants four feet apart in the row. Others plant in the garden, placing the plants two feet apart, if only one row is planted, and in four feet rows with the plants three feet apart if there are to be several rows. On good, strong deep soils, it is well to give plenty of room, for large growth of leaves is desired to impart vigor to the roots. Distance depends somewhat upon the variety, but nearly all growers aim at very large leaf stems, and these require ample space.

J. B. Wagoner, however, in growing winter varieties, advocates close planting. He says:

> If you want a rhubarb crop, you must feed the plants—with nitrogen. If you feed them well, you may let the roots enlarge as much as they will, the new eyes will produce the stalks. Let the root get big—the bigger the better. Set your plants close together—1½ feet apart in rows 4½ feet apart, 6000 per acre—and give them plant food. When they are crowded close together, they occupy less land, they send up straight stalks that pack well, the leaves shade the stalks from sunburn, they shade the ground reducing evaporation, and, hence, irrigation, the soil does not bake and reflect the summer heat up to the stalks. The thickness of the leaves shades the stalks so they color well up to the end. When frost comes, the leaves protect the stalk again.

Treatment.—The plants should be allowed to retain all their leaves the first year after planting out, and there must be abundant moisture for summer growth if there is to be a heavy crop the second year. Frequent summer cultivation is desirable unless mulching is employed, and if it is the grower must be sure that his mulching is heavy enough to retain moisture. It is probably better to trust to cultivation and irrigation in most situations. With the fall rains the surface should be liberally dressed with manure and covered in as deeply as possible without injury to the roots. Shallow cultivation should follow before the weeds advance too far, to be repeated as necessary to keep the field clean.

Winter growing varieties, planted out in the spring and summer, irrigated, establish themselves so strongly the first summer that some pulling can be done upon them the following winter. Even without irrigation, spring set plants will receive a new impulse with the first rain, grow riotously with the autumn heat and give large leaf stems by the holidays in the warmer parts of the state.

Manuring and cultivation should be followed year after year to keep the soil rich and in good tilth. Some soils are, however, so rich naturally that such liberal manuring may not be necessary at first. The plant should not be too fully stripped of its leaves nor should the pulling be continued too late with the summer varieties. The following crop depends upon adequate leaf action—consequently the plant must have foliage and summer moisture to maintain it.

Soil Shading and Enriching.—Mr. A. W. Lee, of Covina, holds that in interior places rhubarb is greatly helped by soil shading. He grows blackeye beans or cow peas between the rhubarb rows in the summer. It is not to protect the plants from the sun, but for its fertilizing value, especially the humus that it will produce; but, while it probably does not shade the plants, it shades the ground and keeps it moist if kept irrigated and cool, and this is a very material help in keeping the sun from injuring the plants.

"If you are in a hurry for rhubarb results," says Mr. Lee, "and if your patch is badly run down or the fertility gone, 200 or 300 pounds nitrate of soda per acre, used with manure, revives it. In applying commercial fertilizers, I furrow away both sides of the row, drop the fertilizer in, and cultivate to fill the furrows. Then a good irrigation is necessary to start the fertilizer to work. I use dried blood in the same way. I spread manure on top of the ground and cultivate or plow it in, rather than scraping it into the bottom of the furrow. Fresh cattle manure is best. Rhubarb uses lots of nitrogen.

Slight Forcing of Summer Rhubarb.—Mr. R. E. Hodges notes interesting garden experience as follows:

> In our garden in San Mateo County, the rhubarb started to go to seed early this spring. We cut off the seed stalks before the sheaths bursted and stopped that tendency. But the leaves and stalks would not grow much. We

put bottomless boxes over three of the seven plants, after pulling all leaves but the very smallest. Two weeks later the rhubarb was pulled to eat. That in the boxes averaged considerably over twice as large as the best of that outside. The boxes were just large enough to fit over the plants, forcing the smallest leaves to point upward.

For early forcing for home use, take a deep box, make up a mixture of stable manure and garden soil, plant strong roots in this and water well. Place this in a dark shed or in the cellar and water every three weeks or so, and get forced rhubarb.

Varieties.—The Monarch is largely grown. It has a very wide, flat stem. The Victoria has red, long stems, rather sharp acid, but a very productive sort and popular. Linnaeus is early, large, thick stems, of excellent flavor and less acid. Strawberry is largely grown in the great summer rhubarb district around San Lorenzo, Alameda county.

The Crimson Winter, introduced from Australia by Luther Burbank about 1895, and sold by him to the trade in 1900, has revolutionized rhubarb growing in California by completely reversing the market season. This variety and its improvements by Mr. Burbank and by others who have practiced selection, notably by J. B. Wagner, of Pasadena, who originated Wagner's Giant and has multiplied the rhubarb acreage of the state and vastly increased the serviceability and commercial suitability of the plant. It has precluded forcing in California and promises to render forcing unprofitable even in the wintry parts of the country because of the large supplies of open air rhubarb which are available for shipment from this state at all times of the year when the summer varieties grown in wintry climates are unproductive.

The winter varieties are not reported satisfactory on the flat rich lands of Alameda county, where the chief crops of summer varieties are produced. For most profit they are grown on deep, light soils where frosts are very light. From such places they reach an early winter market and do not compete with summer varieties.

CHAPTER XXXI.

SPINACH.

COMMON SPINACH.—*Spinacia oleracea and spinosa.*

French, epinard; German, spinat; Dutch, spinazie; Danish, spinat; Italian, spinaccio; Spanish, espinaca; Portuguese, espinafre.

NEW ZEALAND SPINACH.—*Tetragonia expansa.*

Spinach is an all-the-year plant in California, and the house-gardener need never fail to have tender foliage for boiling if he arranges for successive sowings and knows the varieties and species which befit the changing seasons, for he can choose for fall sowing that which is perfectly hardy and thrifty in the California winter, and for spring sowing that which will furnish succulent pluckings even through the heat and drought of the interior summer. But though this is so, it is chiefly as affording winter greens that spinach is grown for the market. The summer furnishes so large a variety of table vegetables that it is chiefly in winter that the housewife turns her attention to pot-herbs.

Culture.—As we are dealing with two entirely distinct genera of plants under the name "spinach," and as they have very little in common except their similar culinary use, it will be necessary to write in specific terms of their culture.

The varieties of common spinach (*spinacia*) dislike heat and drought and enjoy moist, rich soil and moderate temperature. These conditions are afforded by all California gardens in the winter, providing the grower will heed the suggestions for ridge-culture, etc., given in previous chapters, for escaping surplus water and securing suitable growing-temperature in the winter garden. With these provisions it is easy to secure winter spinach by following the suggestions given for the winter growth of lettuce, peas or other hardy vegetables. What has been said of fall sowing of these, applies also to spinach. The plant makes best growth from seed sown in place, and if the seed is good it may be thinly sown, for the plants should not be allowed to crowd each other. They should have from six to nine inches space in the row and should be kept free from encroachment of weeds. To keep the soil from packing by rains, and to push the plants as well, a top dressing of fine manure may be placed to be leached out by the rains. In a garden with permanent walks, spinach may be sown as a border plant, which brings it within easy reach for the frequent plucking of leaves. The plants will endure this, and by means of new growth on old plants and successive sowings, it is feasible, as above stated, to have spinach always ready. The variety chiefly used is the "Large Prickly," although the "Long Standing" is also esteemed because of its long leaf growth before sending up seed stems. The Round of Summer is also considerably used.

For greens in the hot and dry summer and dry autumn, the New Zealand spinach is making a fine record in California. It was introduced and widely distributed by the State University, and has been handled for years by the California seedsmen on the basis of its local suitability. Even in interior situations it grows on dry ground all summer, and maintains rich green color until frost kills the top growth. The stems and foliage are very sensitive to frost, but the root is more hardy and gives new growth and is useful in the spring. The plant sends out shoots of considerable length which may be cut off for cooking. Its tenderness and flavor are vouched for by many growers. Early summer cutting may be had by starting plants with bottom heat and planting out like eggplants, but in our long summer, sowing in the spring after frost danger is over, gives abundant foliage in late summer and autumn.

Spinach has recently added greatly to its commercial importance in California by the operation of the canners. Large fields are grown especially to fill contracts with the canneries. It is the winter growing varieties which serve this demand. They are grown by rainfall from fall planting.

CHAPTER XXXII.

SQUASHES.

MAMMOTH SQUASHES OR PUMPKINS.—*Cucurbita maxima.*
French, potirons; German, melonen-kurbiss; Danish, centner-groeskar; Italian, zucca; Spanish, calabaza totanera.

MARROWS AND SCALLOPS.—*Cucurbita pepo.*
The species *moschata* also contributes same horticultural varieties.

The California-grown squashes are all noted for prodigious size and the acre-product is also immense. Squashes have been used from the early days as exponents of size in California vegetables, at all distant and local exhibitions, and the statistics thereof would fill a volume. Weights of single specimens have been attained in excess of three hundred pounds, and field crops above thirty tons to the acre. To avoid exaggeration and at the same time present the truth about the California squash in a picturesque manner, a single record is presented from the writer's collection of cucurbitous literature. Frank E. Kellogg, of Goleta, Santa Barbara county, personally known to the writer as a man of truth and probity, furnishes this statement:

> I planted my squashes in May, and harvested them in October. Finding that they were unusually large, I weighed ten of the largest and found that their aggregate weight was one ton and fifty odd pounds, the largest one weighing 225 pounds. This squash was exhibited at the county fair and received the first prize. On the 15th of November, which was my boy's sixteenth birthday, I cut open one of the other squashes, that weighed 210 pounds, and took out the seeds; my boy then got into it and I put the piece together and completely closed him in, the parts coming tight together. I then persuaded my eighteen-year-old daughter to get into it and I closed her in, in the same manner. My daughter's weight was 110 pounds. I then put two seven-year-old boys in at once. I then put my three little girls in at once; they were aged respectively six, four and two years, their united weight being 116 pounds. I placed the largest child in the bottom and the little one on the top and then put on the lid; the squash was cut so that the top could be easily put on or removed. The squash was three feet four or five inches in length.

The growth and productiveness of the plant in specially favorable places are proportional to the size of the fruit; vine growth of fifty feet and from thirty to forty-two good sized fruits to the single vine are recorded—a good wagon load to the vine.

Localities and Soils.—The greatest specimens and the heaviest crops are produced on rich, retentive loams. These are rather heavy soils and are usually the lowlands of either coast or interior valleys. But great squashes are not confined to such soils. Lighter soils, if abundantly rich and adequately moist, are also very satisfactory, and in fact any good soil deeply plowed and properly cultivated, until the vines cover the ground, may be expected to give good returns. For this reason the dairy farmer who has suitable land, grows squash in large quantity for fall and early winter feeding; the mixed farmer enters squash as a stated item in his list of crops, and the fruit farmer is quite apt to grow squash between the trees in his young orchard, to contribute to his family milk supply.

The squash may often help to use waste land. J. W. Scott, of Stanislaus county, keeps his ditch banks cultivated all spring that he could grow squash on them for hog feed in the fall. In ordinary years a big lot of land is wasted in ditch banks, but by keeping them cultivated there is room for two rows of squash on Mr. Scott's ditches, and as the land in them sub-irrigates all during the summer they will require very little care after planting. Mr. Scott uses a crooked neck variety because of less damage from worms.

The squash is somewhat exacting in its moisture supply, and does not respond well on light, dry soils unless irrigated. With enough moisture the plant endures the highest interior heat and records large production. Excessive irrigation is, however, to be avoided, for it is apt to diminish the fruiting.

Culture.—The squash plant is very tender; it is destroyed by frost and the seed is apt to fail in cold ground. The proper practice is to have the soil previously well cultivated, but to delay planting seed or transplanting seedlings from the covered bed until the time is frost-free and the soil warm. The culture of the squash is, therefore, like that already prescribed for the cucumber and for melons, in Chapters XXI and XXIV, to which the reader is referred. The bush varieties of squashes follow the cucumber in distances, and the running varieties follow the watermelon distances. There is, however, some difference in the practice of growers of the running varieties; some advocate rather close planting, as six by six or eight by eight feet in squares, and others plant at wider distances, even to setting two plants in a place at intervals of fourteen feet apart. It is impossible to state any specific distance at best; it is to be determined locally according to the growth which the local soil and climate produce. One is apt to err on the side of crowding than otherwise.

Care must be had not to cover the seed too deeply. It must be firmly placed in moist soil and covered enough to avoid quick drying. The suggestions in Chapter XI on propagation are as definite as they can be made, according to the character of the soils employed.

Cultivation must be begun as soon as possible after planting, to save moisture from loss either by weeds or evaporation, and must be frequent for the same reason. Nothing looks more distressful than squash vines perishing on baked clay or dry sandy soil which, if properly cultivated from the start, would have sustained a splendid growth.

Garden Culture.—In addition to injunctions for thorough working of the soil and adequate irrigation, there is the opportunity in garden culture to produce grand results by special fertilization. Careful use of the compost or liquid manure described in Chapter VIII, produces marvelous results.

Varieties.—We have in California probably all the kinds of squash known to horticulture. Some amateurs take special interest in such collections, and scores of varieties representing the whole gourd family have been shown in state fair exhibits. And yet the bulk of the product is made of very few varieties.

Of the bush forms which are relied upon for summer squash, the Scallops comprise most of the crop; both the early white and yellow being grown—the former preferred. The yellow crookneck is also grown to some extent, and its advocates hold it best adapted to early planting because less liable to frost injury, but it must not be trusted too far. The Italian and Boston marrows have a few warm advocates.

Of the winter squash for table use, the Hubbard and the Red or Golden Hubbard, which is a little earlier, are chiefly grown, while the Boston Marrow, with sweet, high colored flesh, is a favorite with the canners. The field squash crop is made of several varieties. The California Marrowfat, a splendid, orange-colored squash, takes the lead, while associated with it in the same field may be found the Mammoth Chile, which is usually the sort, more or less pure, which yields the largest specimens. There is also a very large winter crookneck, very prolific and rather more hardy in trying situations, but not so good in keeping quality as the preceding. Here and there may be found a field of the old-fashioned New England pumpkin, and fair exhibits usually bring to light both the Etampes and Tours pumpkins, but the large orange and light olive fruits are named squashes in the California vernacular, and are preferred. There is much confusion in the terms "squash" and "pumpkin," and there are many chance hybrids which await analysis by some cucurbitous specialist.

CHAPTER XXXIII.

THE TOMATO.

TOMATO OR LOVE APPLE.—*Lycopersicum esculentum.*

French, German, Spanish and Portuguese, tomate; Dutch, tomaat; Italian, pomo d'oro.

The tomato is one of the most popular, prolific, and profitable of California vegetables, and is by far the greatest of all the canned product, as shown in Chapter I. It is grown everywhere during the local occurrences of the frost-free period, and in our thermal situations the fruit can be gathered all the year. The earliest fruit in our local markets and the earliest shipments to the East are gathered from vines which have continued growth from the previous summer and autumn, and, encountering no killing frost, are able to fruit through the early winter months. Favorable places in the southern coast counties are best known for this winter crop. The winter-grown fruit is, of course, inferior to the summer and fall crop, though it is excellent enough to command high prices for table use until the earliest yield from spring plantings is to be had. When this new crop comes in, the fruit from the hold-over plants becomes cheaper, but is still marketed until the new crop becomes abundant. In this way one year's plants in southern thermal situations continue production near to the yield of the following year in the earliest interior sections at the north, and the tomato supply from open air plants is almost continuous throughout the year, though the supply regions are hundreds of miles distant from each other. The fact that the North produces earlier spring tomatoes from new plants than the south is difficult for distant students to realize. It is conditioned upon ocean influences and local topography, which at the South prevents frost which winter-kill the old plants at the North, and at the same time postpone spring heat at the South, which is attained earlier in sheltered places in the interior at the North from which ocean influences are excluded. There are places in the interior at the South, east of the high mountain range, which should be earlier than either the southern coast or the northern interior, but this theoretical advantage has not yet been realized in large production as high heat seems to come on so soon after planting out in March that fruiting is reduced.

In the all-the-year California demand for the tomato, it is necessary to bring some fruit from Mexico and from the forcing houses of the southern states, and it is probable that more forcing of tomatoes will be undertaken in this state in the future. It is a question, however, whether we should take to forcing under glass or make use of cozy nooks where tomatoes need no such appliances. Mr. G. P. Rixford, of San Francisco, informed us in May, 1916, that he had seen a three-year-old tomato plant, still producing fruit, in the vicinity of Porterville, Tulare county. At another place in the same region he saw a one-year-old plant with plenty of ripe tomatoes.

No vegetable has advanced so rapidly in public esteem during the last decade as the tomato, and in addition to our great output of canned tomatoes California shipped in 1916 about twelve hundred carloads from August to January, which were chiefly grown in Los Angeles and Orange counties. Other large producing regions are around the bay of San Francisco and in the Sacramento and San Joaquin valleys.

Shipments of fresh tomatoes are not only in late fall and early winter to the East but in spring and early summer many carloads go to the upper coast states and to mountain states, where the crop is late or difficult to grow at all.

Requirements of the Tomato.—For spring planting of tomatoes which are to attain their chief growth before the close of the rainy season, somewhat elevated situations, above the lowland frosts, and with light, warm soils and free drainage, should be selected. Sometimes frosts will occasion replanting, for which a stock of thrifty plants should always be in readiness. It is idle to attempt the growth of early tomatoes on a commercial scale except on situations naturally fitted for them. In the family garden slight covering from frost can be successfully undertaken.

For the main crop of tomatoes, rich, lower lands, either naturally retentive of moisture or supplied therewith by irrigation, are usually employed. Even heavy valley soils are profitably used by thorough preparation before planting and cultivation afterward. Late planting can be practiced and immense yields are secured for harvesting in September and October, when the fruit is of superior solidity and the canneries are clear of their summer fruit work and can turn their full capacity to this most popular canned vegetable. In some parts of the state, November and December tomatoes are very profitable when autumn frosts and rains are light.

The moisture requirements of the tomato are moderate, but they must be adequately met. Stunted vines and small, inferior fruit are the results of drought. High heat can be endured and favors growth, provided ample moisture is available. The more moderate heat of the coast regions and the interior river bottoms is, however, adequate for full development of the plant, and it is attained with much less moisture than on the higher lands of the interior. For this reason splendid crops are secured without irrigation on retentive soils in valleys of sufficient rainfall, even if the plants are not set until the opening of the dry season—provided suitable winter and spring working is given to prevent evaporation and to hold moisture near the surface. On lands moistened by underflow splendid tomatoes can be grown without irrigation all through the local frost-free period.

Growing Plants for the Garden.—Tomato plants may be grown from stem cuttings as described in Chapter XI, but they are usually grown from seed and the best plants are those produced with moderate heat. They need protection from cold rather than forcing heat, as our day temperatures from February onward are almost always adequate. For early starting of plants some bottom heat is often desirable and can be profitably used if care is taken for free admission of air and subsequent hardening of the plants by later growth under protection but at lower temperatures. The considerations urged in the chapter on propagation for the handling of seeds and seedlings have special applicability to the growth of tomato plants. For the home garden there is perhaps no better way of growing plants than that of Ira W. Adams, as follows:

> Plant the seed about the middle of February in a small box two inches in depth and keep in the house by a south window in a moderately warm room. On warm, sunny days, put them outdoors, and let them remain out day and night whenever the weather is warm enough; in this way they will make stocky plants and be much hardier than if raised altogether in the house. The soil should be rich and mellow, and always kept a little moist. When the plants appear, thin out to an inch apart. As soon as the plants begin to crowd each other, transplant to another box, about four inches in depth and give them a space of four inches. By the time they crowd each other again they can be transplanted outdoors on the south side of the house or barn into a good-sized bed of rich soil. Here they can remain until they get to be large, strong, hardy plants, with very large, fibrous roots. When all danger of frost is over, take a sharp spade and cut out a square of dirt with each plant, put into rows six feet apart, with the plants the same distance in the row. Plants can be transplanted in this way when over a foot high and in blossom. By transplanting them just at night, or on a cloudy day, they will hardly ever show a wilted leaf.

Another way to secure large plants for garden planting is to start them in a seed-box, in the house, or with bottom heat as described in the chapter on propagation, and then transplant when small, into growing cases made of discarded fruit cans. Select those of similar size, throw them on a burning brush pile for a few minutes, when the tops and bottoms will drop out, and the seams on the sides will open, leaving a smooth tin shell. Tie a string around each to keep it from spreading. Set them in a box or frame made of four boards. Fill the cans and the spaces between them with good friable soil, set a small plant in the center of each shell, sprinkle well and keep moist. When the plants are well grown they may be transplanted in the garden. Take the cans carefully out of the frames, grasping the cans firmly to prevent the plants and soil slipping out; set them in a box or wheelbarrow and move them where wanted. Prepare the soil by working in a shovelful of well-rotted manure where a plant is to stand, but this is not required if the soil is rich. Dig a hole deep enough to set the upper rim of the can level with the ground, cut the string and fill up and press the soil firmly around the can, then by spreading the top of the can a trifle, it can be drawn out over the plants without disturbing the roots. If the weather is dry and warm, water may be used at transplanting—drawing loose soil around the plant after the water soaks away.

It is also practicable to use small containers in the hot-bed, such as small pasteboard folders, berry baskets, etc., as described in Chapter XI. In such case the seed is planted in the container and the plants thinned to one and set out later without removing the container, which will soon decay in moist soil.

Growing Plants for Field Planting.—The above methods will produce plants of great size and vigor to delight the amateur. For a field crop it is hardly practicable to grow and handle plants in such an expensive way, and satisfactory results can be attained with much less labor. For late planting they may be grown in quantity in a cold frame with cloth cover or in a raised bed with slight protection from frost and sheltered from cold winds, or even on the open ground in frostless places. Large quantities are often grown from the seed by simply thinning the seedlings as they stand, though the transplanted seedlings are always more thrifty and stocky. They have a much better root-system, and grow more thriftily after transplanting. Take the seedlings when they have come in the rough leaf, and with a small hardwood stick, made pointed at one end, take up the young plants and dibble them in clear down to the seed leaf. Place them about three inches apart each way, water them well, and in a few days they will begin to grow, and in this way fine, stocky plants can be grown almost ready to blossom when they are set out in the open ground where they are to remain. There is nothing gained by setting out tomatoes in the open ground when they are too small; if anything, time is lost by doing so, while a large, stocky plant has plenty of fine fibrous roots, and is rapidly established in its new place.

A detailed account of growing tomato plants in open seed-beds for field planting is given by Prof. S. S. Rogers* as follows:

> The customary method for raising the plants in the seed-beds is by sowing the seed in drills from three to six inches apart or by broadcasting. The former method is preferable for the grower who has had a limited experience or for purposes of producing rapidly growing plants. Soil which is used for this purpose should be light and worked to a very fine condition of tilth before seeding. It is desirable also to spade under a heavy coating of stable manure long enough in advance of seeding to insure thorough rotting. It will aid in germinating the seed if burlap or muslin be placed on the surface of the ground until the plants have appeared, at which time it should be removed. The seed should be covered with from one-quarter to one-half inch, and sand is found desirable, especially if the soil in the bed is of a heavy nature. Beds should be located on a well-drained spot, preferably on the south side of a fence or building. Water should be piped to the beds so that they may be easily sprinkled. The beds should be sprinkled often enough to keep the surface moist, watering frequently rather than in large amounts at longer intervals. Many growers

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*In Circular 147 of University Experiment Station, Berkeley.

sprinkle lightly once or twice a day until the plants have appeared at the surface. Where the surface covering has been used water may be applied through it. Care must be taken not to have the soil too wet, for the young plants are very liable to injury. Where very early plants are desired, growers sometimes heat the water before applying it. After the seedlings appear watering should be done very carefully and should be governed entirely by the condition of the plants and there is more danger from too much than too little irrigation. During cloudy weather, the beds should not be watered unless absolutely necessary and the sprinkling should be done in the morning so the surface and the tops of the plants may dry before night.

After the seedlings are from two to four inches in height they should be thinned to two to five inches between plants; the beds carefully weeded and if in drills, the soil between the rows thoroughly stirred. A week or so before the plants are to be taken from the beds, watering should be stopped and if they have been grown under some protection, this should gradually be removed in order that they may become "hardened off," for if the plants are removed when they are growing rapidly, it is difficult to get them established without seriously checking their growth. A few hours before removing the plants, the beds should be thoroughly wet to aid in preserving the fibrous roots. If the plants have grown too large, the tops should be cut off to about six or eight inches from the ground before being transplanted. An experienced grower may be able to take up plants properly by pulling them up, but it is best to use a shovel or trowel, cutting off the roots about four inches below the surface and taking up with adhering earth. The plants may either be placed in pans or in baskets, or rolled in sacks and carried to the field, care being taken not to expose their roots to the air longer than is necessary.

Field Planting of Tomatoes.—Preparation of land for tomatoes should begin early in the rainy season, as for beans, corn or melons, to render the soil absorptive of moisture and to secure good deep tilth. Re-working in the spring, and cultivation until it is safe to plant out the tomatoes, keeps the soil in fine condition, saves moisture and insures a crop at minimum cost. Crops are often grown on spring plowing alone, but it is an uphill task, and attended by great risk of failure, if spring rains are scant, as they often are.

Field planting is generally done by hand, sometimes at the intersection of cross-markings, but often with less care, by placing the plants firmly on the side of a furrow and covering with another furrow. Some large growers use the transplanting machine mentioned for sweet potatoes, and it works well when the soil is in good condition. A special note made of this machine as it was seen at work is as follows:

> On a ten-acre field in Solano county three men were planting tomatoes early in May, as fast as the horses could walk. A middle-break plow is fastened between two wheels at the end of a wagon tongue. Following this is a knife between two four-foot wheels, which digs deep in the ground and is flared into two blades behind, to leave an opening for the plants. A barrel above the middle-break supplies water through a hose to this opening. One man drives, two men ride seats close to the ground so they can take the tomato plants from the platforms in front of them and place them in the freshly moistened opening as the machine travels. Two curved knives follow the cutter knife to rake the dirt tight up to the plant. The tomatoes were being set about five feet apart each way and about six inches deep. They promptly wilted in the noonday sun, but recovered the first night.

For late planting especially, and in light soils, it is desirable to set the plants quite deeply in the soil. The rule with some growers is to set the plant half the length of the stem deeper than it stood in the seed-bed and in light, dry interior soils the stem has been entirely buried with good results. Depth of planting depends upon the character of the soil and its content of moisture. Where moisture is to be abundant it is better to have the roots nearer the surface.

Distance depends upon variety. The usual distance is six feet apart each way or four by six for the standard growers, but some plant more widely, and dwarf varieties are set at intervals of four feet.

Summer Treatment.—Very seldom is any effort made even in garden culture to support the plant above the earth surface. As the crop is largely grown without irrigation or with sub-irrigation by seepage from ditches, the earth surface is always warm and dry, and rot is almost unknown. The soil should be cultivated as long as it can be done without injury to the prostrate plants, and hoeing to prevent baking of the soil around the stem should be faithfully done as long as practicable. Two or three hoeings and four or five cultivations are usually given. Well-grown plants on rich, moist soils almost cover the surface even when given the widest distances.

It is commonly believed that excessive growth of foliage retards ripening and reduces fruitage. Whenever this occurs, as on very rich and moist interior soils, free cutting back of the plants with a scythe, is practiced with good results. Summer pruning of over-rank garden plants is also desirable.

Irrigation.—As already stated, the tomato abhors dry soil, and in some situations irrigation is essential. Care must be had against over-irrigation, especially in the coast region, where proper planting and cultivation will give satisfactory results with the natural moisture. It must be remembered that it is not desirable to get a large vine-growth but much fruit on a relatively small plant. Not only does excessive watering during the early growth of the plant cause dropping of blossoms and promote foliage at the expense of fruit, but too much water after fruit is set is apt to give a tomato which slices up into cart-wheels instead of firm and solid discs of flesh. Most growers cultivate too slackly, especially when irrigation water is used.

Irrigation by flooding is sometimes successfully practiced, but application of water which does not wet the surface beneath the plants is preferred.

Tomatoes With Much Work and Water.—Quite a departure in all respects from general California methods are those of Mr. S. Dalforno, of Merced county, who shipped 3500 20-pound boxes of tomatoes in 1916 from 14,000 plants on his adobe soil. The plants were transplanted in mid-February from hot-beds to cold-frames, being set an inch deeper than they were in the hot-bed, but not over the seed leaves. They were transplanted to the field in April when about 12 inches tall, having already in some cases had their laterals taken off. The plants were put one foot apart in trenches three feet apart and were set about six inches deep. A light irrigation was given at planting, the ground being cold. A stake about four feet high was placed beside each plant which was tied to it with coarse string. About 10 to 15 days after the first watering, a heavier irrigation was given, as the ground was warmer then. Through the hot weather water was given every three or four days. After the first irrigation, ground was cultivated toward the vines to keep water away from them. As they grew, they were suckered three times in the season, leaving only one leader to grow up beside the stake. Its terminal bud was pinched off at four feet high and the energy of the plants went mostly into producing fine, big, smooth, clean fruit. The stakes and staking more than paid for themselves in increased quantity and quality of crop, as well as labor saved in picking. The tomatoes set in three distinct crops a foot apart on the vines.

Picking Tomatoes.—Tomatoes for shipping should always be picked right. For such purpose the fruit should be picked when slightly blushed, not by squeezing or pulling. Encircle it with all the fingers and twist carefully, leaving the stem on the vine, or rub it off afterward, if it parts from the vine. Do not leave the stem end on the fruit. Pick in shallow boxes, not in deep pails or baskets, and use two receivers; one for perfect fruit, the other for culls. Do not handle the fruit roughly, even if it seems very firm.

Yield.—With all conditions favorable, tomatoes make a very large return. Twelve and a half to fifteen tons of marketable tomatoes have been gathered as an average per acre from large tracts, and yields as high as twenty-five tons have been reported. The largest specimen of which the writer has record was grown in Calaveras county, with the following dimensions: circumference, twenty-two and one-half inches; diameter at widest place, eight inches; weight, four and one-half pounds. Mr. Ira W. Adams reports that he grew one year one hundred and thirty-six pounds of ripe tomatoes from one vine, and when the frost came picked thirty-four pounds of green ones. This vine covered a space of nearly eight feet square; it grew on the edge of a ditch used for running water to blackberry vines. It was an instance of ample irrigation by seepage.

Varieties.—California grows all the many improved tomatoes with which American seedsmen have enriched our vegetable list, and new varieties should always be looked for in California seedsmen's catalogues. They always offer choice yellow varieties for preserving. Varieties which include those commercially most prominent, are few and are as follows:

Sparks Earliana: very early, tall growing; fruit large, smooth, scarlet; flesh deep red, solid.

Chalk's Early Jewel: nearly as early; fruit large, smooth, regular in form and ripening evenly; bright scarlet; continuous bearing.

Dwarf Champion: low growing, upright; fruit medium, pink to purplish red, according to locality; popular in the interior heat, especially at the south and in the foothills of central California.

Stone: tall and fruitful; fruit large, smooth, uniform, bright red, solid; widely popular in California for canning and shipping. A Dwarf Stone, resembling Dwarf Champion in growth is also a good shipping variety at the south and New Improved Stone is also approved in that part of the state.

San Filippo: firm and of good color; popular in the San Francisco bay district.

Ponderosa: a strong growing vine; fruit very large, somewhat irregular and variable in color, usually light red; flesh thick but not always firm.

Trophy: vigorous and productive; fruit deep red, somewhat irregular, solid and firm in the true type, with ring-mark at apex; chiefly grown for canning in Alameda county, displacing Stone.

San Jose Canner: large, scarlet, smooth and solid and very productive; fine table variety and approved by canners.

There is an opinion current among California growers that even the best of the eastern improved tomatoes are still further improved by California growing conditions if constant selection is practiced to preserve the best types. For instance the "Trophy" is very largely grown as a late tomato for canners' use, and planters insist upon securing California grown seed, but careless seed saving resulted in Trophies widely different from the true type and very inferior.

In each of the large growing districts there is much to be learned about the locally most satisfactory varieties by observation and inquiry. Cannery managers and field men should also be consulted as to varieties most acceptable for their uses. The amateur, however, is not hampered by such requirements and can range the large lists as he pleases.

TOMATO TROUBLES.

The tomato plant has a number of diseases of which the plant pathologists of the University have made close study for several years and of which Circular 147 by Prof. Rogers, to which allusion has been made earlier in this chapter, gives the latest account. The first to be encountered, that is in the seed-bed, is "damping off," which has been discussed in Chapter XI. Next is the "winter blight," a blackening of the leaves, which is prevented by the Bordeaux mixture applied as soon as its first signs appear. Then there is "blossom end rot," which seems to be controlled by culture and irrigation which gives the plant regular and adequate soil-moisture. "Leaf spot" shows itself in angular spots with pale centers and colored edges and is checked by Bordeaux mixture. "Summer blight" kills plants usually in the spring and the symptoms are curling and yellowing of the leaves and collapse of the whole plant quickly. No cause has been determined. Fortunately plants set after June for the main crop are less seriously affected than earlier in the season. No treatment seems to have any effect.

In the bay district plants are attacked in the field by a black beetle, which is prevented by wrapping the plants in six inch square pieces of newspaper and planting in this wrapper—which both roots and tops soon outgrow.

CHAPTER XXXIV.

TURNIPS.

TURNIP.—*Brassica napus.*

French, navet; German, herbst-rübe; Dutch, raap; Danish, roe; Italian, navone; Spanish and Portuguese, nabo.

KOHL-RABI.—*Brassica caulo-rapa.*

French, choux-raves; German, knollkohl; Flemish, raaphool; Italian, cavolo-rapa.

RUTABAGA.—*Idem.*

French, chouxnavets; German, kohlrübe; Dutch, koolraapen onder den grond; Italian, cavolo navone.

These members of the cabbage family are somewhat arbitrarily classed as turnips for convenience and in accordance with local popular usage. Kohl-rabi has swollen stem, clearly above ground; rutabaga has a swollen root partly above ground, partly below; the turnip proper is another species of *brassica,* which has a swollen root and a manner of growth like rutabaga. In California all these vegetables take a much lower rank in popularity and usefulness than the cabbage group of the same genus discussed in Chapter XVI. Judged as root crops they are inferior in use and esteem to the other esculent roots already considered. They have no local standing whatever for stock purposes, for two reasons at least: they do not endure well our summer heat and drought, but become a prey to fungus and unthrift; they will not rest and start again for larger root-expansion, as do the beet and carrot. Such being their weakness and perversity, the stock feeder abandons them, which he can readily afford to do in view of the fact that he has many other more serviceable crops. He can have any quantity of immense beets and carrots which are making their re-enlargement from the previous spring sowing, to feed in the winter; he can have for late summer use, corn and squashes, which grow riotously in summer heat which distresses the turnip. He does well enough without the turnip, in view of its behavior and his own supplies from other sources.

At one time, however, the turnip was coming widely into favor in the dairy region of Humboldt because it developed more rapidly from spring sowing and would be ready for feeding in July and August, while beets and carrots came considerably later. But the creameries shut down on turnip-milk because of bad flavors. This ruling largely closed the career of the turnip although the cool, moist air of Humboldt county's summer is greatly to its liking.

The vegetables, then, which we group in this chapter, must be estimated alone upon their table value, and here, too, they are afflicted by an ill-indisposition. They are not good keepers in this climate, and, though they can be packed away in sand for use during our warm, rainy winter, the people have other supplies of fresher character in the winter, and do not find either turnips or parsnips as desirable as they are in wintry countries.

Turnips and rutabagas are then reduced to claim popularity upon their excellence as quickly grown for immediate use when mature, and under this restriction they centainly enjoy a fair measure of popularity. Kohl-rabi is very little used and its narrow fame is chiefly confined to citizens of French and German descent.

Culture.—The growth of all these plants is simple and can be undertaken anywhere in California, providing their dislike of summer heat and dry air is borne in mind. The culture methods prescribed for the beet and carrot befit the turnip in the direction of preparation of soil, sowing the seed and cultivation. The plants are hardy against frost and can be successfully produced all through our valley winters. Sowing for winter use may begin early in the fall on irrigated ground or as soon as the rains fall. Sowing for spring and early summer can be done at any time during the winter when the soil is sufficiently dry and warm for germination and growth of the seedling. In valleys of heavy rainfall and frosts, February sowing may be best for spring use, but in warmer, drier parts earlier sowing is desirable. The plant needs adequate moisture and a moderate temperature, and its growth is a matter of conditions not of the calendar. It is plain, then, that turnips are well adapted to winter gardening in California, and, if pushed to maturity rapidly, they will be found very tender and delicious. Sowing for succession will give turnips fresh from the soil in all their excellence through many months in our warmer valleys.

Both the flat turnips and the rutabagas or Swedish turnips are grown in the same way, and both reach edible size very quickly under favorable conditions. Culture is like that advised for the radish except that they need wider spacing. Rutabagas are better keepers and more serviceable for winter storage than flat turnips, though both are mainly used fresh from the ground in this state.

Rutabagas are sometimes transplanted from the seed-bed, as space becomes available here and there in the garden for them. They are handled just as cabbage plants are.

Kohl-rabi is grown in the same way as common cabbage, both in starting plants and planting out.

Varieties.—The flat turnips chiefly grown are Early Snowball, Early White Dutch and Purple Top Milan—the latter being preferred by market gardeners. The Purple Top Flat Dutch or Strap Leaf and Purple Top White Globe are also in good favor.

Rutabagas are so little grown that there is doubt which has the preference of several good kinds listed by our seedsmen; the Purple Top Yellow or Long Island seem, however, to be most popular.

Of Kohl-rabi the White Vienna is usually grown.

CHAPTER XXXV.

VEGETABLE SUNDRIES.

It is not intended to make this volume a complete treatise upon the esculent plants which may be grown in California, nor to claim that it contains a complete enumeration of those which are actually grown at the present time. Such a task would be appalling in view of the wide adaptability of the climate and the fact that our population includes natives of every country under the sun who have brought hither the plants which have delighted them in their old homes. Conspicuous among such contributions to our cultivated flora are the acquisitions from China and Japan, which alone would require much time to identify and characterize. Our acquisitions of minor vegetables from Europe are hardly less interesting. It must be left for some future student to properly arrange all these for public information. In the present work it has been rather the intention of the writer to treat the more conspicuous and widely useful vegetables, because in that line the present demand for information lies. An attempt will, however, be made in this chapter to briefly mention a few plants concerning which inquiry may arise in the minds of readers, and to offer suggestions on their culture.

CAPERS.—*Capparis spinosa.*

The production of "capers" on a commercial scale has frequently been mooted in California, and so far as the local adoption of the plant goes, anticipations of success seem to be well placed. The plant thrives with moderate moisture—enough could be conserved by cultivation on any fairly retentive soil. It has been growing thriftily for years on adobe soil in the University garden in Berkeley, and has produced prolifically the flower-buds which are used in pickling. The labor of frequently hand-picking the buds must, however, be considered in connection with any projected enterprise. A few plants for the home garden can be strongly commended. They can be grown in corners or in borders and are decidedly handsome in leaf and blossom. Plants may be easily grown from seed in a seed-box or can be multiplied by stem cuttings in a sand-box over mild bottom heat.

CHAYOTE.—*Sechium edule.*

This squash-like vegetable was introduced to California by the late Kinton Stevens, of Santa Barbara, previous to 1890 and was first called "choco" and classed as a fruit.* It belongs, however, among the vegetables and in southern California has become of commercial note. It resembles a squash and is cooked in many ways. It is a free-growing vine and very productive. One California grower reports a single vine bearing more than 350 fruits, averaging more than ten ounces weight. D. F. Reichard, of Los Angeles county, gives the California Cultivator these cultural points:

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*California Fruits; 2nd Edition, p. 480; 1891.

> Being a tropical vine it grows only in warm weather. In southern California it is planted in February. The fruit, which envelops only one seed, is planted whole with the large end down, leaving the small end out of the ground. The young plant sprouts from the large end. Plant where they are to grow in well drained soil. Keep them only damp enough to allow good growth until warm weather comes on, when they will require lots of water. If the early sprouts are frozen back do not be alarmed as new growth will soon appear. The first year runners 20 to 30 feet will be made and probably some fruit. The winter frost will freeze these runners back to the root, but in the spring new shoots will come out and will grow to from 30 to 60 feet, which, if well trellised, will produce hundreds of fruits. During September the white, insignificant blooms begin to appear; in four or five weeks the small fruit are old enough for use. They are cooked and used the same as summer squash and eggplant.

CHERVIL.—*Scandix cerefolium and Chærophyllum bulbosum.*

There are two edible plants known as chervil, the first furnishes fragrant leaves which are used as seasoning and in salad, the second an edible root for boiling. The first is a hardy annual, and can be grown from seed, as lettuce is—sowing whenever moisture is adequate. It does not thrive in high heat but can be helped by shading when necessary. The turnip-rooted chervil resembles a carrot in form, and may be grown as carrots are. The seed soon loses its germinating power and must be fresh.

CORN SALADS.—*Valerianella olitoria and eriocarpa.*

Corn salads are popular winter growing salad plants, and are of easy culture. The seed is sown whenever moisture is present in the fall, and a succession of foliage can be had all through the rainy season. The culture is the same as for lettuce. The plant also resembles lettuce; we have some varieties of open growth and some which are disposed to form somewhat compact heads of foliage. In this state both the French and Italian improved kinds are hardy in California valley winters.

CRESS.—*Lepidium sativum,* and WATER CRESS.—*Nasturtium officinale.*

Garden cress is easily grown all the year in the coast region if the ground is kept moist. The seed should be sown at short intervals, as the leaves come on very quickly. In the interior it is chiefly a winter plant, as summer heat checks leaf growth and carries the plant to seed. Water cress has grown freely in California ponds and pools, and was found in such places by our earlier botanists. In California it makes very rank growth, producing stems five and six feet high and proportionate luxuriance of leaf growth. It usually volunteers freely wherever water stands, filling road-side ditches and similar places. All that is needed is to prepare a place suitable for its growth. By making new, zig-zag ditches, just a little off the level or contour line, so the water will run very slowly, one can grow any amount of cress that he can find use or sale for and pluck it continuously from the old roots, but it is not wise to have anything to do with it in a commercial way until one understands it fully. It is used for garnishing, for salads, for boiling as greens, etc. There is little chance of selling cress except in cities, and there is small chance of profit far away from city consumers because the cress will wilt before one can deliver it.

DANDELION.—*Leontodon taraxacum.*

This plant has been widely introduced on the moister lands throughout the state, and is used for salad and for boiling, as it appears in abundance after the fall rains. The plant is also grown to a limited extent by foreign-born market gardeners, and some of the improved garden varieties have been introduced for their use. It can be grown as lettuce is, whenever the soil carries moisture enough.

GHERKIN.—*Cucumis anguria.*

This plant is different from the small pickling cucumbers which are often called gherkins. It is a creeping, branching plant, making a dense mat of stems well laden with small, oval fruit covered with spine-like protuberances. It endures heat and drought well, and is very prolific even in interior situations in California.

GINGER.—*Zingiber* sp.

Ginger is the commercial product of the roots of several species of Zingiber—some of them strictly tropical, others rather more hardy—but two conditions are essential: Freedom from frost and assurance of continual soil moisture. The plant is propagated by planting pieces of its fleshy roots which roughly resemble those of the sweet flag. These are planted about three inches deep in a light soil mulched with well-rotted manure and kept moist continually by irrigation. Under such conditions the plant makes a large weight of fleshy roots. Ginger root has been planted in California many times during the last forty years or more and we hear now and then of the plant growing in a garden, but there is probably no chance of succeeding with it as we usually grow field crops, and no one should plant it except in an experimental way.

KITCHEN HERBS.

It is hardly desirable to enumerate a list of culinary herbs. Each housewife has her own information and preference and beyond that her cook-book is an encyclopedia. Suffice it to say that nearly the whole collection of plants grown in northern climates for fragrant leaves or seeds is hardy in the California winter, and most of them do best with early sowing—as soon as the soil is well moistened by the fall rains. Most failures with them are traceable to sowing too late, which comes from following eastern practice. Where the winter is quite frosty, fall sowing is less desirable, but with February warmth the seed should be in the ground. Early sowing enables the plants to secure good rooting, and with that, growth can be carried later in the dry season. Late sowing causes many a plant to dwindle in the summer heat even if irrigation is afforded. It must also be remembered that many plants must be diligently cultivated during our dry season which thrive without it in the humid summer of other countries.

Mushrooms.

Field growth of mushrooms is abundant during the rainy season in California—especially do the fall rains bring to view such great quantities of them that they can be easily gathered by bushels. The list of edible mushrooms in California includes many species which afford a fine field for mycological epicures. Recently there has arisen quite a producing interest in the line of cellar culture of mushrooms chiefly by foreigners, and their methods are essentially the same that are practiced elsewhere, descriptions of which are readily available. Good detailed publications can be had free on application to the Secretary of Agriculture at Washington which will give the inquirer a good outline of arrangement and methods.

An outline of California practice, which Mr. Peter Arndt of Los Angeles found successful, is as follows:

> Mushrooms can be grown in the cellar for home use providing the cellar can be kept at an even temperature with plenty of light and air, but large and profitable crops in a specially built house or in an old out-building properly fitted for their growth.
>
> Start with a bed 10x10 feet—which sounds like a very small beginning indeed, but this size bed should produce at least 200 pounds of mushrooms.
>
> Secure a two-horse load of horse manure. Wet it down thoroughly, and turn it over daily with a pitchfork. As soon as it dries out pretty well, wet it again, and repeat the turning over process. Do this for about ten days, and then transfer the compost or manure to the beds you have already prepared.
>
> Pack the manure thoroughly in the bed to a thickness of about seven inches, and let it stand. Place a thermometer in the bed, to a depth of about three inches; the temperature will rise to about 75 or 80 degrees. When the temperature reaches this point, cut your spawn into pieces about two inches square and set into the beds two inches below the surface and one foot apart. It should be right to set the spawn one week after packing the bed.
>
> One week after setting the spawn cover the bed to a depth of one-half inch with fine sifted garden soil; after that sprinkle the bed lightly from time to time; just enough to keep it moist, but not wet.
>
> The mushrooms will start to appear in from six to seven weeks. If you can keep your bed at a temperature of about 60 degrees you will get fine results, but a temperature of from 45 to 75 degrees will do, and with proper sprinkling will produce just as good results as an even temperature of 60 degrees.

Beds can be built one upon the other leaving about two feet of space between each bed. Never use a dark room or house for mushrooms, but be sure that the beds are protected from the direct rays of the sun. A little artificial heat is a good thing in the winter as the temperature should never be allowed to go above 70 degrees or below 40 degrees. The house in which the beds are located should be on rather high ground—at least high enough to afford good drainage.

MUSTARD.—*Sinapis* sp.

Mustard is a grievous weed in California, especially on rich soils with moisture. It is also sometimes very profitable as grown for a seed crop. The young plant is sought in the fields as a salad and improved varieties are cultivated to some extent. Both the white and the large cabbage-leaved Chinese kind are grown. The culture is most easy and simple, the treatment being the same as that of lettuce.

NASTURTIUM.—*Tropæolum.*

Nasturtiums are largely grown as ornamental plants, but the desirability of the flowers for the garnishing of salads and the use of the flower buds and green seed for pickling and as a substitute for capers gives the plants space in the vegetable garden. They will thrive almost without care or watering in a corner of the garden, though better growth will show their appreciation of better treatment. They volunteer freely in California from self-sown seed and continue growth all through the frost-free season. They can be trained on fence or trellis or allowed free range as prostrate plants if space permits; or dwarf varieties may be chosen, as they bloom and fruit freely with less extension. They require little more from the grower than the covering of the seed in soil moist enough for germination.

OKRA OR GUMBO.—*Hibiscus esculentus.*

This popular vegetable of the South is not largely grown in California but can usually be had from market gardeners. It requires generous moisture supply to thrive and does not take at all kindly to dry heat. Plants may be started in the winter in the ways described for the tomato, and the planting out and treatment is like that of eggplants; or seed may be sown for later crop in the open ground in drills, the plants being subsequently thinned to about a foot apart. The plants should be well cultivated and kept well supplied with water. The Long Green and the White Velvet are the varieties chiefly grown.

PARSLEY.—*Apium petroselinum.*

Parsley can be readily grown in California by the use of a raised bed for fall sowing for winter use and by sowing in the early spring for flat culture for summer use. The culture is like that for lettuce except that the plants need wider spacing and extra care has to be taken to protect the seed from drying out, as it is long in germinating and cannot be deeply covered. Good firming of the ground after previous deep culture is desirable, and a light mulch will help to retain moisture and facilitate watering without crusting the ground.

ROSELLE.—*Hibiscus subdariffa.*

This interesting plant, resembling in its growth okra or gumbo, is a native of tropical Asia and Africa, and has been widely distributed through semi-tropical countries, where it has been found to possess considerable resistance to drought and to yield very acceptable food products. It was introduced by the pioneers probably from Mexico, and was distributed by the State University about 1895, and has been offered by California seedsmen for many years past. The plant is very ornamental, the dark red stems and pods showing through the rather scant dark green foliage. The flowers are of a yellowish white with a dark red center, two inches across and lasting only an hour or so during fair weather. The juice extracted from the fleshy calyces or husks is used with water to make an acidulous cooling drink, but is of most value in jelly-making. The mucilaginous properties of the juice render the "setting" of the jelly certain, with a reasonable amount of cooking. The dark cherry color of the jelly and the sprightly acid makes it nearly if not equal to currant jelly. Irrigated plants produce a more highly colored fruit, but come into bearing later. Unirrigated plants put their strength into fruit, but the irrigated plants start lateral branches, which ultimately produce several pods, while the unirrigated plants have but one pod. As the plant will endure quite heated and arid situations, it promises to be of much value for jelly-making where currants do not thrive. The plant should be given ordinary garden culture, sowing the seed when danger of frost is over. Enough of the pods should be allowed to ripen to yield seed for the following year.

SEA KALE.—*Crambe maritima.*

This plant is but little grown in California, and then only by professional gardeners. It requires long use of the ground and considerable attention in provision for blanching. Plants may be grown from seed, if it is fresh, as tomato plants are grown, and planted out at about three feet apart each way. Plants can also be grown from root cuttings as described for horse-radish, placing them about three feet apart each way. Plants from root cuttings should be allowed free growth for at least one year, and seedlings twice as long. Preparation for use consists in covering the plant with an inverted pot or box as the shoots appear and allowing it to make its growth in the dark, thus producing blanched and tender midribs. In cutting, the knife should go below the root crown, as new shoots come readily from below. Old roots are productive for many years if allowed to grow freely but not to form seed after the early growth is cut for use.

SQUARE-POD PEA.—*Lotus tetragonolobus.*

This plant has recently acquired some little popularity in California as a table vegetable. It will make a good winter growth in some regions of the state, though a little spring heat is more pleasing to it. Its culture is like that of garden peas, and, if sown during the rainy season, will bear an abundance of edible pods for early spring use. The pods should be gathered when young and tender and are cooked like string beans.

CHINESE YAM.—*Dioscoria batatas.*

This climbing plant grows thriftily in California and sends its fleshy roots, which are the edible part, so deep that it seems to contemplate return to its native country. To get the roots one has to dig a well several feet deep, because they are so brittle that they will stand no pulling whatever. With present prices of labor in this country it is not profitable to go into deep mining to get starchy food, and the plant is grown only as a curiosity.

UDO.—*Aralia cordata.*

This Japanese vegetable was introduced in 1906 from Japan by Mr. David Fairchild, Agricultural Explorer of the U. S. Department of Agriculture, well known to Californians because of the many visits he has made to the state and the many interesting things he has brought to us from foreign parts.

The edible parts of udo are the blanched shoots, which, when properly prepared, are said to be delicious. Mr. Fairchild gives a detailed account of the growth and uses of the plant in Bulletin 84 of the Department of Agriculture on "Experiments with Udo, the New Japanese Vegetable," but states that he is not certain that udo will prove superior in any detail to vegetables which are already under cultivation in America. Growth of udo was undertaken for eastern shipment by M. E. Meek, near Antioch, Contra Costa county. Mr. Meek planted several acres, and Mr. Fairchild says it is the first commercial field of it in the United States.

CHAPTER XXXVI.

VEGETABLES FOR CANNING AND DRYING.

The importance of vegetable canning in California is noted in the opening chapter of this work. At the present time large areas of vegetables are grown to fill contracts with canners, and their purchases in open market are a great relief in times of over-supply. It is reasonable to expect that this important canning interest will largely increase as larger distant markets can be commanded, and as the growth of population west of the Missouri river demands greater supplies. California has marked advantages in the production of canning vegetables at minimum cost and in the highest quality.

As this treatise is prepared for the information of vegetable growers, it seems fitting that some space should be given to an exposition of what constitutes excellence in a vegetable from a canner's point of view, although it is impossible to enter into the subject as fully as its importance warrants.*

Asparagus.—The trade demands large, white, tender spears, with the tip wholly unopened or headed out. To secure the shoots in this condition, they must be cut very closely, which is done by keeping the soil in fine, deep tilth, and cutting low, as nearly as practicable, before the point is exposed to the air. A few hours' growth in the sun not only causes the head to color, but it begins to open very rapidly. Other information has been given in the chapter on asparagus.

String Beans.—This vegetable has not been canned to any considerable extent in California, inasmuch as the fresh vegetable is on the market such a large portion of the year, that there is less need of buying it in cans. The first canner who made a specialty of string beans was Mr. H. Wambold, of Blue Lakes, Lake county, who had a piece of land that seemed to be better adapted to the production of string beans than any other vegetable, and this land was used for the same crop for twenty consecutive years. The yield from the commencement being so large, the home market so limited, and being too remote from the railroad for shipping to the San Francisco market, he was forced, as a last resort, to pack the vegetable, and by strict attention to every detail he soon built such a reputation for his canned beans that his yearly output is easily disposed of at a good profit. The points of quality in a string bean for canning, are green color, tenderness, and it must be as nearly as possible stringless, or, at any rate, a variety that can be easily handled, leaving no strings on them, when ordinary care is used. Recently the business established by Mr. Wambold has been greatly expanded and others have engaged largely in it, including a considerable corporation organized to operate in Lake county.

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*The fullest account of California's commercial canning industries, including buildings and machinery, methods, materials, etc., is "The Canning of Fruits and Vegetables," by J. B. Zavalla. John Wiley & Sons, New York, 1916.

Peas.—The desirable points in this vegetable from a canner's point of view are that they shall be small, green, sweet, and tender. There are a great many varieties which have been handled successfully in this state, as stated in the chapter on the Pea, such as Premium Gem, Alaska. This vegetable is so dependent on atmospheric moisture that a crop cannot be counted upon every year in the interior; for lack of rains at the time when the plant needed moisture, and apparently irrigation does not solve the difficulty, as the pea seems to need a somewhat moist atmosphere. There has been recently in operation a large pea growing interest in eastern Stanislaus county, operating successfully.

Tomatoes.—That fruit must be of red color, firm, few seeds, and smooth skin, that is, not wrinkled. A medium size answers the purpose better than the extremely large varieties. The tomato is canned largely as indicated in Chapter I, and the culture of the plant is fully discussed in Chapter XXXIII.

Corn.—California makes no record in canning corn. The special corn canneries of the eastern states have manufacturing advantages on their side and the eastern corn grower has also advantages. California has a longer green-corn season, as shown in the chapter on that subject, but that counts more for the table than the cannery.

A VARIED PRODUCT.

The statistics given near the end of Chapter I show which vegetables are greatest in California canning but they do not indicate the great diversity in the varieties used. The following are included in canners' operations:

Asparagus
Beans (Lima)
Beans (Baked)
Beans (String)
Beets
Cabbage
Carrots
Celery
Corn
Onions
Parsnips
Peas
Potatoes
Potatoes (Sweet)
Peppers (Chili)
Pimientoes
Pumpkin and Squash
Sauerkraut
Spinach
Tomatoes
Turnips

DRYING VEGETABLES.

Very fine samples of dried vegetables have been shown from time to time in California, and the output of a considerable product in this line is clearly feasible if it could command a welcome in the markets. This fact has not yet been demonstrated. The rush to Alaskan gold fields in the summer of 1897 created a demand for considerable quantities of dried vegetables, chiefly potatoes, and the drying establishment of Penniman Brothers, of San Jose, which was opened for vegetable drying in 1889 and subsequently turned to other uses for lack of demand, was turned again to vegetables to supply sharp orders for Alaskan shipment. Onions, potatoes, string beans and carrots were dried and several slicing machines were used. A drying establishment at Azusa, Los Angeles county, was also operated for vegetables during part of the season, and others probably participated. Interest in commercial vegetable drying revived during the European war and a large establishment was equipped near Stockton for drying and flouring potatoes. If demand and prices should favor it California could produce large quantities of dried vegetables as well as dried fruits. Experience thus far seems to favor machine evaporation rather than sun drying, but it is quite probable that sun heat may be found available, at least for part of the work, when further attention is given to the matter. The commercial development of vegetable drying is, however, very slow as compared with the production of fresh and canned vegetables for distant shipment.

For home use the drying of many kinds of vegetables is very desirable. During 1917 under the nation-wide movement for food conservation there was much effort expended to preparing detailed advice and instruction concerning vegetable drying and many publications resulted, describing many improvements in methods. Such publications can be had free of cost from the U. S. Department of Agriculture at Washington, D. C., and from the University of California Experiment Station at Berkeley, to which the reader is referred. These sources furnish all information needed for the beginner, who will find out, however, that he has much to learn also from his own experience.

For the convenience of the reader the following outlines of methods of both canning and drying vegetables with ordinary home appliances are compiled from publications of the University of California by Professor W. V. Cruess:

PRACTICAL DETAILS OF CANNING VEGETABLES.

1. Make a false bottom to fit inside an ordinary stove wash-boiler. This bottom may be a piece of heavy wire netting or a wooden grating.

2. Prepare the vegetables as for cooking and in convenient form for placing in the cans. Root vegetables should be brushed clean, peeled and cut into convenient slices or pieces. Green beans should have their strings removed and then be cut into short lengths. Peas should be shelled. Corn should be cut off the cob. Peppers should be scalded and the skin removed. Squash should be peeled, the seeds removed, and the flesh cut up into small pieces. Asparagus should be blanched or parboiled by dipping into boiling water for about three minutes immediately before canning. Artichokes

should have some of the outside bracts removed and the hardtip cut off with a sharp knife.

3. The prepared vegetables are packed tight into the jars or cans which are then completely filled with brine containing three ounces of salt to a gallon of water. Before using, this brine should be acidified with lemon juice or vinegar. For corn ten fluid ounces (about one and one-half teacups) of lemon juice should be used to a gallon of brine, for beans and peas seven fluid ounces (about one teacup), and for other vegetables five fluid ounces (about three-fourths of a teacup). If ordinary vinegar is used about twice these quantities are necessary. The acidified brine should be poured hot on to the vegetables.

4. The filled cans and jars are then placed, with their covers in place but loose, on the false bottom of the boiler. Hot water is then poured into the boiler until it reaches to about three-fourths of the height of the jars. A second tier may be placed on a rack resting on the first tier, to be cooked in the steam.

5. The boiler is then covered and heated to boiling, for one hour for most vegetables. Pumpkins, beans and corn require two hours.

6. After this heating remove and seal quickly, while still boiling hot, by screwing down the tops of the jars or applying the wax to the cans.

This is a thoroughly safe and satisfactory way of preserving vegetables. With some vegetables the acid may be omitted, but in this case two or three repeated heatings are necessary and this lowers the quality of the food to some extent. Reheating is not practicable with wax-top cans.

The foregoing is called the "cold-pack" method because the material is put in the cans before cooking. In the "hot-pack" method the prepared material is first cooked with the necessary water or brine in an open kettle and poured hot in the cans and sealed immediately. In most cases this is sufficient for preservation, but an additional heating after sealing is often necessary.

With the cold-pack method the canned material retains its form better, but more liquid is needed. The hot-pack method is more economical of heat and more solid material can be packed in the can.

TOMATO PASTE.

Canned tomatoes contain about 95 per cent water. If evaporated to about one-eighth or one-tenth of the original volume the concentrated product will contain all the food value, flavor and color of the fresh tomatoes.

The following method of manufacture is applicable to household conditions: Boil the tomatoes until soft. Crush thoroughly and pass through a fine sieve or screen to take out the skins and woody portions of the pulp. Place the pulp and juice which pass the screen in a shallow pan and boil down gently over a slow fire to a thick consistency. As the water evaporates the pulp will thicken and become liable to scorching. Before this occurs, place the pan at the back of the stove where the heat is not sufficient to cause the paste to stick to the bottom of the pan. Allow the pulp to evaporate under these conditions very slowly until it has become very thick and pasty. While still hot add about 2 ozs. of salt to a gallon of the paste and pack into hot scalded jars. The filled jars should be sterilized in a washboiler sterilizer for half an hour to an hour, as desired for canning. The jars should then be sealed.

The tomato paste can be used in cooking just as fresh tomatoes are, as a flavoring for various dishes, or diluted and used as soup stock, etc.

A flavored tomato paste is made by Mrs. Jessica Hazzard, of Los Angeles: To one gallon of tomato juice and pulp prepared as above, add two sliced onions, two buttons of garlic, one bay leaf, and two or three Chili peppers. Boil down over a slow fire until it thickens and then concentrate over a steam bath or on the back of the stove to a thick paste. Beat in olive oil and salt to taste. Store in jars or cans. It will keep fairly well without sterilizing, but may become moldy on top. If sterilized it will keep perfectly.

This method of preserving tomatoes will save nearly nine-tenths of the jars usually used for tomatoes. It is simple and effective. The main danger to be avoided is that of scorching the product during evaporation.

PRESERVATION BY SALT AND SOURING.

Vegetables can be preserved more cheaply than in cans or jars and more simply, for household use, than by drying, by making use of the preservative qualities of salt and of lactic acid.

1. *Preservation in Brine.*—The vegetables are washed and sliced. They are then placed in a crock or barrel or other wooden vessel containing a strong brine. Metal vessels cannot be used. The brine is made with 2½ to 3 pounds of salt to one gallon of water. The vegetables must be kept submerged by means of a well-fitting wooden cover weighted with a stone or similar object that will not be acted on by the brine.

2. *Preservation in Salt.*—Prepare the vegetables as above. Weigh and take one pound of salt for each two pounds of prepared vegetables. A layer of salt is first placed on the bottom of a crock or barrel and then a layer of vegetables. Similar layers are alternated until the vessel is full, finishing with a good layer of salt. A wooden cover is then applied and weighted. After a few days there will be a considerable shrinkage in volume and the vessel can then be filled with more layers and weighted as before.

These methods are suitable for most root vegetables, string beans, cabbage and cucumbers.

3. *Preservation by Fermentation.*—Cabbage, string beans, beets, and cucumbers can be preserved by covering with a weak brine and allowing them to undergo fermentation out of contact with the air.

The prepared vegetables are mixed with salt at the rate of one-quarter to one-half of a pound of salt to ten pounds of vegetables and tightly packed in a deep crock or barrel and weighted down. The salt and pressure force out the juice of the vegetables and they decrease in volume one-third to one-half. After a day or two more vegetables and salt may be added and the weight replaced.

If kept in a warm room (65 to 70 degrees F.) a gaseous fermentation commences and continues for several weeks. This produces lactic acid, which preserves the vegetables. When the fermentation is over and the vegetables taste a little sour the liquid is drawn off and replaced with a brine containing one-half of a pound of salt to one gallon of water. In this they will keep in good condition for a long time if well protected from the air.

The large quantities of salt used in these methods must be removed by soaking in fresh water ("freshening") before cooking.

DRYING ROOT VEGETABLES.

The method described below is suitable for turnips, carrots, beets, potatoes and other similar root vegetables.

1. Peel or scrape the roots and cut into slices ¼ to ⅜ of an inch thick.

2. Spread in a single layer on wooden trays. Those used for fruit or raisin drying are good. Suitable light trays can be made from pine shakes or even from old boxes. They should be about 2 ft. × 3 ft. with a 2-in. cleat on each end and a ½-in. strip on each side.

3. Expose the sliced vegetables on the trays to the fumes of burning sulfur. An ordinary "sulfur box" used in drying fruits can be used.

A simple sulfur box can be made of a large dry goods box or of a wooden frame covered with ordinary tar paper to make it fairly air-tight. It should be large enough to hold six to twelve stacked trays. It should be open at the bottom and if large have a door at one side for the insertion of the trays. If small it may be simply put over the stacks of trays. It is placed on the ground with the open side down over a hole at one end of which the sulfur is burned. It should be long enough so that the trays do not come directly over the sulfur hole at the end.

As soon as the box is filled with trays of the sliced vegetables, the sulfur, in a shallow iron or earthenware pan, is placed in the hole and ignited. The door of the box is then closed. In from ten to twenty minutes the sulfuring is complete. A handful of sulfur is sufficient for a large box.

Field squash in Arroyo Grande Valley, San Luis Obispo County.—Page 262.

Photo Sacramento Co. Supervisors

Fruiting of California tomato plant disclosed by clipping away foliage.—Page 265.

Vegetables can be dried without sulfuring, but the color, flavor and keeping qualities are less perfect and the drying slower. Potatoes are particularly improved by sulfuring.

4. Place the trays in the sun until the vegetables are dry. This will require two to five days in good weather.

Drying Potatoes.—Select sound, well matured potatoes.

Method A: Peel and cut into pieces about one-fourth to three-eighths of an inch thick. Spread on trays and expose to the fumes of burning sulfur for twenty minutes. Place the trays in the sun until the potatoes are dry. If uncooked potatoes are dried without previous sulfuring the product will be dark in color.

Method B: Boil or steam the potatoes until they are nearly cooked. Peel and cut in slices or run through a meat chopper and dry on trays in the sun.

To use potatoes dried without cooking soak six to eight hours, or overnight, using eight pints of water to each pound of potatoes. Cook them in the usual way. If the potatoes were boiled before drying, they may be cooked in water or milk without previous soaking.

Sweet Potatoes.—Use sound mature potatoes.

Method A: Wash and boil until nearly cooked. Peel and cut in slices or run through a meat chopper. Spread on trays and dry in the sun.

Method B: Wash, peel, slice, spread on trays and dry. The color will be lighter if the sliced potatoes are dipped in salt water before drying.

DRYING TOP VEGETABLES.

Tomatoes, peas, corn, squash and cabbage may be successfully sun-dried on trays in California. They may be kept indefinitely in the dry state and when properly cooked they are wholesome, nutritious, and can be made very palatable.

Peas.—Select peas at the best stage for cooking fresh. If too ripe they will taste like ordinary split peas when dried, and if unripe they will dry down too much. Shell and spread on trays. If wooden trays are not available, paper, canvas or cloth may be used. Expose to the sun until dry. Unless thoroughly dry they will mold when stored. At the proper stage of ripeness it requires about 10 pounds of unshelled or 3½ pounds of shelled peas to make a pound of dry peas.

Corn.—The corn should not be too ripe. It should be tender and sweet. Remove the husks, place the corn on the cob in a wire basket or sheet of cheesecloth and immerse in boiling water for about three to five minutes. Chill immediately in cold water and cut the corn from the cob. Spread on trays in the sun and dry.

Tomatoes.—Bright sunlight and dry weather are essential for sun-drying tomatoes. Cut the tomatoes in two flat-wise or large fruit may be cut into thick slices. Spread on trays and dry in the sun. It may be necessary to turn several times to prevent molding. Dry until tough and leathery in texture. They are then packed tight in barrels or boxes. A little salt should be sprinkled between the layers.

Pumpkin and Squash.—Cut into strips and peel. Cut the strips into slices about one-fourth of an inch thick. Spread on trays and dry.

Cabbage.—Select well developed heads. Remove the outer leaves and cut into strips about one-fourth or one-half of an inch thick. Spread loosely on trays and dry in the sun. About eighteen pounds of fresh is required to give one pound of dry cabbage.

Peppers.—Commercial drying of peppers is outlined on page 237. Stringing in the sun is still a good method for home use.

STORING AND COOKING DRIED VEGETABLES.

Dried vegetables may be kept in glass or stone jars, closed bins or heavy sacks or otherwise protected from insects. With small quantities it is a good plan to wrap in bundles with strong paper and store the bundles in cloth sacks. To guard against insects hatching from eggs deposited during the drying, the vegetables should be placed in shallow pans and put in a moderately hot oven for a few minutes before storing. The same treatment can be used later with vegetables found to be infested after putting away. Another way to destroy insect life is to put the material in a tight covered box and allowing bi-sulfid of carbon to evaporate from a saucer placed on top just below the box cover. Half a cupful is enough for a 2 ft. × 4 ft. × 3 ft. This vapor is explosive and should be used in the open air and away from lights. Its offensive smell will soon dissipate by exposure to the air after treatment and no injury be done to flavors.

Cooking Dried Vegetables.—As a rule dried vegetables must be soaked in cold water for 24 hours before being cooked. A pinch of carbonate of soda added to the water makes them more tender. They can be used as fresh vegetables, but are particularly suitable for soups and stews.

Special suggestions are as follows: Corn should be soaked two to four hours, using two cups of water to one cup of corn. Peas should be soaked about twenty-four hours before cooking. Dried tomatoes will require at least twenty-four hours soaking or longer to soften and remove the excess of salt. To cook dried pumpkin or squash, soak over night in ten pints of water to one pound of dried material. They can then be used for pies, etc., in the same way as the fresh vegetables. To cook dried cabbage, add seven cupfuls of water to one heaping cupful. Bring *slowly* to a boil in an open kettle. Boil thirty minutes. Add salt to taste. This may be used for creaming, etc.

After soaking, dried vegetables are seasoned and cooked in ordinary ways. The drying process results in some loss of flavor and the dried products, therefore, require more seasoning than fresh vegetables.

CHAPTER XXXVII.

SEED GROWING IN CALIFORNIA.

The commercial production of garden seeds in California was entered upon by the first American vegetable growers as a branch of their business. The difficulty of obtaining supplies from the East and the almost fabulous prices which seeds commanded, acted as a strong incentive to local production. The inventory of Mr. John M. Horner's productions at Alvarado in 1851 included eleven hundred pounds of garden seeds—onions, beets and cabbage. Mr. A. P. Smith at Sacramento had twenty acres devoted to seed growing in 1857, and the following record shows that he had been doing a good business for some time before that date:

> To his vegetable seed department Mr. Smith turned his attention at an early day, and has pursued it till now he devotes to it twenty acres of ground and the time of several laborers, and from it reaps a merited reward. His crop of seeds for the last four years has reached from three to four thousand pounds per annum, which up to 1858 averaged about three dollars per pound. They now sell for less.[1]

Another pioneer seed grower was Mr. D. L. Perkins, of Alameda. The record states that he "served a thorough apprenticeship in the business at the East and is quite at home in all general operations connected with his business." At the state fair in 1860 premiums for garden seeds were awarded to A. P. Smith, of Sacramento, and to D. L. Perkins, of Alameda. The committee reported both exhibits very meritorious and indulged in the prophecy that "the time is at hand when our gardeners will be saved the time, trouble and expense of looking abroad for their seeds."

It would seem that Mr. Perkins must be credited with a broader conception of the opportunity of California in seed growing than was known to the awarding committee. With them the problem was local supply. Mr. Perkins looked beyond that. In his statement submitted with a claim for a gold medal at the state fair of 1867 he uses these significant words:

> For the past ten years all my time has been given to the raising of seeds . . . striving to get the best seeds from all parts of the world. During the past three years I have sent collections of seeds to be tested at the East and the results in size and quality over the same varieties grown at the East have been so marked that several parties have ordered from me, thus showing that California can compete with the world for garden seeds. There is no State in the Union so well adapted to the raising of seeds as California. During five years past I have sent samples of my product to Japan, China, Sandwich Islands, Mexico, and to Europe.[2]

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[1] Rep. Cal. Agr. Society, 1858, p. 233.

[2] Condensed from Rep. Cal. Agr. Society, 1866-7, pp. 228 and 229.

Probably this statement of Mr. Perkins was the first formal prophecy of the eminence which California would ere long command in the seed markets of the world. It found an echo in the words of Peter Henderson, the veteran seedsman and florist, who wrote in 1882: "California will, I am certain, fifty years from now, grow seeds for the world. It has all the conditions of soil and climate for seed growing." The progress attained during the last few years justifies Mr. Perkins' enthusiastic declaration and indicates that Mr. Henderson's time limit was certainly conservative and safe, for in certain lines surely such a position has already been realized and was reached in less than a third of his period.

A New Start.—Mr. Perkins did not continue to the demonstration of his problem. His intention was diverted to other matters, and it remained for others to actually work the mine of which he was only the prospector. Theirs have been the labors and the burdens, and it is gratifying to add that, through carrying them intelligently and devotedly, they have attained reward and have, in part at least, realized for the state the prominence which was prophesied by the pioneers.

In 1875 Mr. R. W. Wilson, previously a seed grower at Rochester, New York, began seed growing near Santa Clara, and is regarded as the pioneer of the present era of California seed growing. He began on about fifty acres of land, growing principally onion, lettuce, carrot, and beet seed. Two years later he was succeeded by Kellogg & Morse, who continued together, increasing the dimensions of their business until 1889, when Mr. Kellogg retired and C. C. Morse & Co. became the successors to the business. They have extended and developed their enterprise to dimensions which few Californians realize, and are not only leaders in seed growing, but in the seed trade as well. Aside from this large firm there are other producers who have achieved most creditable results in the development of specialties which have given them wide reputations and contributed to the fame of the state in advanced horticulture.

It will be impossible to adequately describe California seed growing in a single chapter. Only a few salient facts can be mentioned.

Onion Seed.—This seed has held the leading place in California seed growing from the very beginning—at first for local use, afterward for distant sale. In spite of the eastern plaudits which Mr. Perkins won for his seed, as already stated, it was a difficult undertaking to induce eastern dealers to use it largely at first. When Mr. Wilson offered his first crop of onion seed in the East, scarcely anyone would touch it and some who did, claimed afterward that the bulbs grown from it were soft, would not keep and were inferior. The next year Mr. Wilson sent quite a quantity of the seed to a dozen or more of the leading dealers who planted it beside eastern seed. In the fall Mr. Wilson went East and personally inspected the crops, compared the bulbs and was able to show that in every instance California seed produced as good onions as that they had been using before. From that time on California onion seed has constantly grown in favor, and this state has become almost the only source of supplies, though there are places in Connecticut and Pennsylvania where a considerable amount is still grown. This popularity secured a price which was quite profitable, and many grew onion seed—too many in fact, for there was in some years a disastrous overproduction. Since then, however, better selection and culture have enabled favoring natural conditions to produce distinctive results. In 1915 Mr. Lester A. Morse wrote as follows:

> Onion seed as produced in California has met and overcome a very decided and persistent prejudice. As a rule the onion reproduces itself better in its immediate environment and Eastern grown or foreign grown onion seed is very likely to run largely, if not entirely, to scallions or stiff-necks when used here. The same result is likely with the onion seed taken from any one climate to another, but California seed will make a well ripened, merchantable bulb in any locality where onions are grown. It is remarkable to be able to pick out a plot of onions grown from California seed in England, or France, or Germany, and find them invariably all uniformly ripe and well matured, free from stiff-necks, and all varieties usually ripen earlier than the same variety from other sources.

Lettuce.—Lettuce seed is a leading crop with California seed growers. The climate of some parts of the coast valleys is admirably adapted to it. It requires careful, painstaking work to maintain choice varieties. Unfortunately, the plant seeds most freely in a semi-wild condition and some of the less critical growers have allowed it to grow in this way, thereby increasing yield and profit. The careful grower proceeds with cultivation fitted to retain the characters of the variety, thins out the plants so that each will form a perfect head and be true to the type, and then the heading or cabbage varieties must have the head cut open with a knife to allow the seed stem to come through; otherwise the plant will rot without running to seed. This method of growing is not conducive to a large seed product, but it improves the strain, while the work of the careless grower tends to reversion.

California lettuce seed is now recognized to be superior. We have the best possible climate for developing, curing, threshing, and cleaning seed. Lettuce requires a semi-arid climate for ripening, and here it receives full share of dry summer weather, so that the sample of seed is immeasurably superior to foreign grown. It is quite impossible to grow lettuce seed in countries where summer rains are frequent.

Other Plants.—But for other seeds than onion and lettuce California seed farms are also famous all over the world and practically all seed dealers know us, but what are commonly known as California vegetable seeds are carrot, celery, endive, leek, lettuce, onion, parsley, parsnip, radish, salsify, and tomato. All of these items are produced on a large scale, and the California crops practically set the growers' prices for the world. All are grown in great variety and all are sold to dealers everywhere.

Peas, beans, except Limas, and vine seeds have not reached large production because of competition with growers in the middle-western states. Eggplant, in spite of the excellence of the vegetable as noted in an earlier chapter, has disappointed the seed growers, and okra has done likewise. Turnip and Brussels sprouts have not prospered as seed crops, while cabbage does excellently. Cauliflower also seeds well some years, but in others it completely fails, which renders its average below the profit line. Lima beans for seed have failed, except in the southern coast district described in the chapter on beans, but in that district growers have enjoyed some very profitable contracts with eastern dealers.

Until about 1910 California grown corn was not supposed to produce good seed, and most of the seed used was imported from the Middle West. It was found that the reason for failure was simply lack of knowledge. When the same intelligence was applied in selection, cultivation, and choice of location as is applied to other kinds of seeds, it was found that our California grown corn seed does better on the Pacific Coast than eastern grown, and the future of corn growing for seed is bound to show a greatly expanding acreage.

Flower Seeds.—Various flowers have been grown for seed, in fact, a great assortment of varieties, and, while nearly all kinds flourish, there is so much hand work and close application necessary, that we have not been able to successfully compete with Europe on most things. Sweet peas, nasturtiums, cosmos, verbenas, petunias, and asters are quite successfully grown, and the seed trade now looks to California for most of the sweet peas and a great many of the nasturtiums. Southern California has several very prominent growers of fine double petunias and other plants. Of standard varieties of candytuft, cosmos, stocks, asters, poppy, etc., there were three growers in southern California in 1915 who cropped fully five hundred acres.

The rapid advance of the California sweet pea seed in popularity is most marvelous. A beginning was made in this line in a moderate way about 1885, when there were not over a dozen varieties listed. At first about a quarter of an acre was grown, but since 1912 the total acreage has been about 2500 acres annually. So important a factor have the California sweet pea growers become to the seed trade that some dealers come from the East annually to inspect the growing crops and to hunt for novelties in the sweet pea line. One will know California sweet pea wherever grown by its wonderful vigor and the flowers are now grown from California seed in all parts of the world.

Sweet peas are planted in November and December to secure the flowers at their very best about the middle of May. They grow slowly throughout the winter, but just as soon as the days lengthen and the weather grows warm, they fairly spring into bloom, while later sown seed will mature blossoms correspondingly late.

The careful grower devotes a great deal of time to rogueing his crops. In spite of the greatest care in selection there will always be a few off plants, and these must come out to keep the stock pure.

One Use of Machinery.—Improved cleaning machinery has proved an important factor in the production of a bright, fresh-looking sample of seed, and has improved the vitality test by allowing a thorough separation of everything spurious from the good seed. Hand mills are employed to some extent for small lots, but the main cleaning is done with large Clipper Mills, operated by gasoline engines, and sometimes the electric motor is used. This gives a steadier power and a much larger capacity. It was not until a few years ago that onion seed could be successfully threshed and separated by one and the same mill. After years of experimenting and great expense, one was built that could successfully do this, and now onion seed is threshed and cleaned by large mills run with steam engines. It is, however, still necessary to sink the seed in water to get it perfectly clean.

Hand Labor.—Nothing has been invented for threshing lettuce, cabbage, parsnip, parsley, etc., which is any improvement on the old hand flail, and gangs of men are employed in threshing these crops. The diversity of the crops and the innumerable variety would make it naturally unprofitable to attempt to employ machinery in the field for these kinds of seed.

The seed grower must depend upon a great deal of hand work. Everything must be harvested by hand; every onion head must be cut by hand; every stalk of lettuce and carrot must be dried, turned, threshed, cleaned and recleaned. Carrot seed must not only be flailed to thresh it, but it must also be run through a rubbing machine to break the beards off and then cleaned in-doors.

All the planting and cultivating must be done very carefully, and much of it is hand work. Every onion bulb must be set right side up in the row—then carefully covered. Celery plants are twice transplanted before being finally set out in the field. Carrots and all roots must be selected and taken out to be transplanted—all which are defective in shape and color being thrown out.

The careful seed grower always makes careful selections of everything he has growing, which he plants separately for his own stock seed. There will always be some roots or plants that are rather better in being nearer the true type and color than the others, and it is from among these that the careful grower makes his selections.

Climatic Advantages.—In addition to the advantages of the California climate in growing the plants, there are other advantages in handling the crop. The long, dry summers afford a fine opportunity to thoroughly dry the seed and permit a large part of the harvest work to be done in the field. It is not necessary to build great barns and drying sheds as they do in the East, although the large California growers provide themselves with large cleaning houses and storage warehouses into which to take the seed as soon as it is sacked and ready for shipment.

The Future.—It has taken all these years to learn how to grow seeds and to have trained a number of men who also know how, and what to do, so that in the future even greater and more interesting developments may be expected in all branches of seed growing. One hardly knows what the possibilities are, but the past has clearly shown that our soil and climate will be great aids to future accomplishment, and in our wide range of natural conditions, it is reasonable to expect that many things not now undertaken, may find a favorable environment, and reward the intelligent and painstaking grower.

CHAPTER XXXVIII.

GARDEN PROTECTION.

There are three main lines of protection to which the vegetable grower may find himself compelled to give attention, and he may sometimes be so beset by ills that he will cry in despair that all forces of earth, air and sky are arrayed against his enterprise. Fortunately, however, there is nothing in the situation, usually, to appall one who is energetic and prompt and eager for success, and an effort will be made to suggest expedients and methods which will assist in repelling various destroying agencies. The three classes of intruders to which attention will be called are these: unfavorable atmospheric conditions; injurious insects and fungi; injurious animals.

PROTECTION AGAINST WINDS AND FROST.

Protection against harsh winds has already been incidentally mentioned from time to time. There are very few places where a good windbreak will not be of decided advantage, and if the garden ground cannot be selected so as to enjoy the protection of trees and buildings already in place, special planting or construction should be undertaken. A good shelter belt of trees, preferably of evergreen foliage so placed as to break the cold winds from the direction prevailing in the locality, will be found of immense advantage. Where such protection is not practicable, a high fence, even if not closely boarded, will afford some protection to a much greater width of ground than one might think at first. Fence-like screens made by interweaving bamboo canes or tall reeds *(arundo donax)* with fence wire, serve well as low windbreaks for small planted areas. These screens can be made in the way described for fencing on page 86 but two or three times as high.

Protection against frost, effective against a drop of several degrees below freezing point, is secured by the use of a smoke smudge. Most effective fires are those which yield volumes of steam as well as smoke, so that masses of wet straw or rubbish placed over dry stuff enough to maintain combustion, are the best material. Running or standing water close to the plants or water sprinkled on them will also prevent frost effect, providing the temperature does not sink very far below the freezing point nor remain there too long. Under such conditions, covers of paper or burlap, also serve a good purpose. The largest use of frost covers is that made by the cantaloup growers of the Imperial Valley, as stated on page 210. They take pieces about a foot square of oiled or paraffined paper and crown it over a seed-hill with lumps of dirt on the corners to hold the paper in place. As the young plants appear the covers are readjusted to them at the time of hoeing. Sometimes the square of paper is humped up toward one side and the folded edges pinned together by a piece of wire long enough to hold the paper-laps together and go into the ground a few inches to hold the cover in place. This makes an opening at the south side which gets larger as the plants rise. The earliest plantings bring ripe melons a month earlier, through the protection which the covers afford. It is a unique sight to see a large acreage covered in this way. It is, of course, only efficient where frosts are infrequent and light.

The whole question of cheapest and most effective frost protection in California is still open, and careful experimentation is proceeding. All growers should read regularly some California horticultural journal in which the latest discoveries and practices are described.

INJURIOUS INSECTS.

It should be borne in mind that the attacks of these evils are in many cases conditioned upon weakness and unthrift to the plant, and the danger from both insects and blights is reduced by keeping the plants in most active and vigorous growth. Lack of cultivation, lack of plant food in the soil, and lack of moisture, are all invitations to these invaders. The natural resistance of the plant is broken down, and it becomes a prey to its enemies. But the best growing conditions do not render plants immune against all pests. Some are so aggressive that the grower has to fight to save his crop, and to fight hard sometimes.

Fortunately, warfare against insects has been greatly simplified during recent years by the use of remedies of comparatively recent application. There are two chief divisions of insects: first, *biting insects,* which are recognized by the gardener by the fact that they make holes in the foliage; second, *sucking insects,* which make no holes, but pierce and extract the sap in such a way that the leaf curls or wilts, loses color and perhaps dies without losing any appreciable part of its surface. Each of these classes has its own remedy.

Remedies for Biting Insects.—Insects which consume the leaf surface are destroyed by poison, and this can be used in such minute quantities as not to destroy the foliage nor render it dangerous for food purposes unless the plant is nearly in condition for eating, and then, of course, poison on the foliage is very dangerous if the foliage is the edible part. If the edible part is the root or tuber, poison on the foliage is not dangerous. The most widely used poison was Paris green until the arsenate of lead rose to such prominence in plant protection, because of its less cost and less danger of injury to foliage. Paris green can be used either as a powder mixed with twenty times its bulk of flour and dusted on the plant, or applied as a spray or sprinkle, using an ounce of Paris green to ten or twelve gallons of water.

Lead arsenate, either in paste or powder form, may be used at the rate of one pound to fifteen gallons of water—well stirred in and frequently stirred during application. A very convenient way is to use arsenate of lead powder as a "dry spray" dusted on the foliage to be protected. Mix the powder with an equal amount of sulphur, flour, sifted ashes or any finely powdered neutral substance. One of the best of these powders is sifted ashes. The mixture is put into a small bag of cheese cloth or other similar material, and shaken over the plants. Being easily seen, the operator can apply as much or as little as he wishes. If applied in early morning the moisture will cause the material to adhere to the leaves more closely. An application every ten days should keep the pests under control except when followed by a rain, in which case the new application should be made.

Either Paris green or lead arsenate will kill all forms of insects, large or small, which make holes in leaves. It only becomes ineffective when insects occur in such vast multitudes that the plant is all consumed before all the insects are supplied with the poison. This would happen in the case of an invasion by grasshoppers or army worms, which, fortunately, does not often occur in garden practice.

For larvæ which come from the ground and destroy the plant by cutting the stem, Paris green and arsenate of lead, either dust or sprinkle, may be placed on tender leaves or sprigs of alfalfa which are placed on the ground beside the plants to be protected. The most injurious insects of this kind are called "cutworms." It is also often satisfactory to use the the poison in this way:

Coarse bran, 16 lbs.; Paris Green, ½ lb.; salt, ¼ lb.; cheap syrup, 1 qt.; warm water to make a coarse, crumbly mash. Be sure not to get the material sloppy; it should fall apart readily in the hand after being pressed together.

Place a spoonful of this near the plants being injured, not getting it too near the stalk. It is a good plan to do this in the evening so the mash will remain moist for a longer time. If a new lot of worms hatch, the dose will have to be repeated. Poultry and pet animals must be kept away.

The same preparation is also very effective for grasshoppers in vineyards, but, as already stated, there is little chance of coping with grasshoppers or army worms in the garden by poisoning. Unless they can be checked by walls of fire or streams of running water around the garden, the gardener has little to do but to replant as soon as they have passed on their way.

When biting insects attack plants which it is not thought safe to poison, the use of a powder of air-slacked lime or of dry wood ashes is often effective in discouraging their attacks. Another repellant which sometimes works like a charm is kerosene powder made by stirring a tablespoonful of the oil to a quart of pulverized gypsum, or air-slacked lime, or even fine road dust. Scatter it on and around the plant.

Plants may also be often rendered unattractive to insects by free sprinkling with tar water. Take a barrel with a few gallons of gas tar in it, pour water on the tar, and have it always ready when needed. When the insects appear give them a liberal dose of the tar water from a garden sprinkler or otherwise; when the rain washes it off the leaves, or the pests return, repeat the dose.

There are other biting and boring insects which destroy plants by their injuries to the roots. Wireworms are a conspicuous group of these destroyers. All underground pests are naturally difficult of treatment and often in field practice they cannot be economically destroyed or discouraged. In garden practice, however, the use of soot or nitrate of soda, in very small quantities, or of tobacco dust, the extract of which is carried down by water to the discomfiture of the pest, is often effective and profitable.

Another group of biting pests though not strictly insects are slugs and snails. They can be poisoned by the use of poisoned leaves lead on the ground, or they can be trapped either with leaves or pieces of board or little piles of wheat bran. Early in the morning the slugs will be found in large numbers under the leaves or boards, or collected in the bran, and can easily be gathered up for breakfast in the poultry yard. Mother hens in portable coops with the young chicks or ducks running among the plants, are a very good solution of the slug question on a small scale. Myriads of slugs in the garden are often due to excessive surface irrigation. If the surface is finely worked up and allowed to dry it is very discouraging to slugs and is otherwise promotive of plant growth.

Remedies for Sucking Insects.—These are pests both large and small which bring distress to plants without visibly consuming their substance, as has already been described. They are not affected by poison on the surface. They must be killed by applications which destroy by contact with the exterior of the insects. The universally approved remedy for this large class of pests is kerosene emulsion. If properly made and diluted, it is harmless to the plant and deadly to the insect. The formula which is most easily prepared and most available for garden work, is that devised by the late Prof. A. J. Cook as follows:

Common laundry soap	¾	pounds.
Kerosene	3	pints.
Water	4½	gallons.

Cut up and dissolve the soap in six quarts of boiling water in a five-gallon oil can. Remove from the fire and add the kerosene, and stir violently until you make an emulsion from which the oil will not separate when cool. This may be done by churning, by revolving agitators, as in an egg beater, or by pumping the stuff back into itself with nozzle and force pump. The last is the commonest way. When the agitation is adequate practically the whole of the mess changes form and becomes like clabbered milk, and this is added to ten or more times its bulk of water, according to the strength you desire to use. One to 20 is strong enough for plant lice. The essential is not in strength, but in getting the dope on the bug with a garden syringe or spray-pump, and it will kill all insects which are covered with a film of it. A fine rose sprinkler can be used, but it is wasteful and the application does not penetrate as well as from a spray-nozzle.

Next in importance to oil emulsions in the warfare against sucking insects are the tobacco preparations and they are so efficient against some small pests like aphis, thrips, white fly, etc., that they are often added to the water used in diluting the emulsions. Tobacco preparations are both home-made and commercial. One pound of tobacco leaves or stems steeped in four gallons of hot water produces a good insecticide. The commercial extract containing 40% of nictotine is used at the rate of one pint to two hundred gallons of water or of diluted emulsion. Nicotine extracts are sold under various names as insecticides by druggists and seedsmen and are usually worth their higher cost because of convenience in securing small quantities ready for use.

The emulsions and tobacco washes will, of course, kill many insects for which poison has been prescribed and are available whenever the use of poison is thought to be undesirable. They have their limitations, however: the stuff must be thrown on the insect while poison will wait for the insect to come to it.

WAYS WITH PARTICULAR PESTS.

The vegetable grower will be armed against insects if he is ready with the few insecticides we have described—to be placed upon the insect's food or upon the body of the insect, as the nature of his work on the plant indicates, but he must not get the idea that the warfare is easy. The appalling rapidity of insect reproduction and the no less appalling number of the kinds of them; the suddenness of their appearance and the diversity of the ways in which they make their attacks—all these should warn the grower to watch his plants closely and to strike fast and hard as soon as he sees the first of the hosts of invaders which he must learn to expect. In the battle with pests an early beginning is more than half the winning.

Although it is obviously impossible to include in a handbook of general practice with vegetables detailed account of all pests likely to be encountered, it may be useful to compile a sketch of frequent troubles in this line with suggestion of ways to meet them—in addition to the notes of particular pests which have been given in some of the chapters on various vegetables.

Plant Lice or Aphides.—Of all garden pests the large group of species of winged and wingless insects known as plant lice are probably the worst. They attack nearly all vegetables and if not checked will destroy whatever they attack. They are sometimes checked by their natural enemies such as lady birds or by unfavorable weather conditions, but in the garden one should be ready to attack them at first appearance with the remedies just described for sucking insects. Their presence should be suspected whenever one sees ants visiting his plants. The ant as a rule is not directly a plant pest but he is indirectly, for he cherishes the plant to grow lice for his use. Therefore, when you see ants running up and down a plant spray to kill the aphis. The ant does not wait until the leaves begin to get curled and misshapen. And if the grower waits for such signs of distress it will be too late to do much for it. As soon as their growth begins the undersides of the leaves should be examined for lice and such examination should continue at short intervals and as soon as any are seen the plants should be sprayed with a nozzle which will hit the undersides of the leaves. They can be killed with ordinary soap suds if the fight is early and often.

Where the plant lice are found strongly established on a single plant or a few plants or hills of plants and not elsewhere it is often desirable to proceed heroically. Early in the spring the insect is often thus limited to a very small number of plants upon which they become exceedingly abundant before developing wings and spreading generally over the field. When this is the case sprinkle gasoline on each of the early infested vines and set fire to it, thus killing all the aphids as well as the plant. This practice may not prevent the final general infection of the field, but delays the time of infestation very appreciably and gives you a chance to keep ahead of the pest by spraying as has been described above.

In a home garden squash, melon and other vines can be dosed for plant lice by turning the vines over; taking up the end of each runner and carrying it back over the center of the hill. This inverts most of the leaves for a thorough drenching without undue loss of labor and material. Care is required that blossoms and young fruit are not damaged, and it cannot well be done after the fruit reaches much size.

Killing Ants.—Though ants do not injure plants in the ways usually attributed to them, their work in cherishing and colonizing plant lice indicates that they should be destroyed—it is easy to get rid of them in a small space like a house garden. Professor Wood-worth of the University gives the following poison for ants in gardens or houses:

	Strong for native ants	Weak for Argentine ants
White arsenic	2 oz.	1 scruple
Sal soda	4 oz.	1 teaspoonful
Sugar	1 lb.	1 lb.
Water	1 pt.	1 pt.

For native ants, expose a small quantity of the strong poison.

For the Argentine ant, place a sponge in a fruit jar, saturate it with the weak poison, make a few nailholes in the cover and keep jar in pantry and several others in the yard about the house. Add more poison from time to time.

Destruction of Nests.—In all the species where there are large nests with a single opening pour down one ounce of carbon bisulphide, either in each of the natural openings or in holes made by thrusting in a crowbar and covering everything with earth. The gas destroys both young and old. This method can be applied to any species where the nest can be discovered, but in the case of the Argentine species it becomes the least valuable of any method, since the nests are usually scattered almost everywhere over the whole surface of the ground and the treatment to be effective would have to include the entire ground space for acres.

When the soil is very dry the carbon bisulphide dissipates too rapidly to destroy the whole nest and better results have been secured with a solution of cyanide of potassium. The method consists in making a rather strong solution (say 8 oz. to one gallon of water) of the cyanide and pouring it into the holes in the same way that carbon bisulphide is used, only more of the material is applied, the amount actually used, of course, depending on the size of the colony. It must be remembered that carbon bisulphide is very explosive and must be kept away from open lights; also that cyanide and its vapor are virulently poisonous to man and beast and must be carefully used. Hydrocyanic gas is liberated in the soil by this means and kills all ground pests it reaches.

Cut Worms.—Young plants that are just pushing through the ground are often found cut off near the surface of the ground, with the wilted tops tilted over or lying near. If you rake in the loose dirt below you will probably find sleek, well fed, greasy, sparsely haired cutworm caterpillars, which are the larvæ of clumsy mottled grey and brown moths which are attracted to lights and many of them can be caught by putting small lamps over pans of water on which is a film of coal oil.

Poisoned bait for cutworms has already been described. They may also be reduced by raking them out of the dirt and crushing them or you can let the fowls scratch them out if they are not likely to injure the plants more than the worms do. Several kinds of birds, incluing the robin, catbird, blackbird, and quail, feed on cutworms. Toads also like them and should be encouraged and protected rather than destroyed. Spiders and wasps also prey on cutworms.

Plants may be protected by pressing stiff cylinders of paper or tin down into the soil about the stems, allowing them to project about two inches above the ground, or each plant may be wrapped in a piece of newspaper as it is transplanted from the seed-bed.

Wireworms.—If the larger garden seeds are not coming up and you dig down and find them being eaten by a flattish, yellowish, slim worm which you try to pull apart and find it very tough, you are being visited by wireworms. You may also find such worms destroying your seed potatoes or burrowing into cabbage stalks or other vegetables with fleshy roots. These worms begin by eating the sprouting seed and continue eating roots until they are fully grown, when they make earthen cocoons in the ground and transform into long, slim beetles which are called skip or click beetles, because they snap themselves over when laid upon their backs.

Wireworms can be fought in the garden by a very thin scattering of nitrate of soda along the proposed rows. They can also be killed by poisoning things which they like, like cut potatoes or other roots, green alfalfa, etc., and burying these in the ground in advance of planting. But if the garden spot is badly infested it is better to make a new garden on clean land and kill out the pests by starving and burning. Go at it in midsummer, plow up deeply (for the worms go down as far as eight inches) and expose the soil to autumn heat and drouth as much as possible. Leave it rough and let it bake and blister in the sun as much as it can, and fence the fowls on it. The following winter put on grain, cut it early for hay and then plow up the stubble and disk it deeply at intervals next summer to continue the drying and burning process on the worms and keep on the fowls to do the catching also. If you keep at this for a full year vegetables will be reasonably safe the year following.

The best natural enemies of wireworms are frogs and toads, and the horned toad is particularly good at them.

Eelworms or Nematodes.—Practically all fleshy roots and bulbs among garden plants are liable to attack by eelworms which are so small that one cannot discern their details without a microscope. Their work is usually manifested by mal-formed or deformed and enlarged roots and rootlets. No treatment has been demonstrated to be effective in destroying them and saving the plant which should be dug up and burned. Dig a hole, put back the diseased roots with a good lot of straw and bake the hole good and plenty. When the crop is off dig or plow up loosely and let the soil bake as dry as possible until the rains come and then plant grain for hay and take a piece of new ground for vegetables if possible. These pests have done great injury to potatoes recently and seed potatoes should be free from them.

Millipeds.—These are "thousand legged worms" which curl up when disturbed into black balls. There are many sizes of them: the small ones, which are hardly larger than shot when curled up, do most harm because most abundant. Some students of them hold strongly that they only affect decaying vegetation, such as potatoes partly decayed, lower leaves of lettuce, etc., but Mr. Essig has found them in a solid lettuce head, so their record is not clear. They may be poisoned by powdering sliced potatoes, lettuce leaves, etc., with Paris green and placing them on the ground, under pieces of board—or they may be trapped under pieces of board or flat stones placed for that purpose and then killed, by hand or foot, as you may prefer.

Diabroticas.—These are often called striped or spotted "green lady birds," but no true lady bird is green nor does she do the bad work of the diabroticas. Their specialty is the squash, melon and cucumber, etc., but they do not hesitate at beans, corn and many other plants. They can be poisoned with lead arsenate as already prescribed for biting insects when they are working on foliage which is not designed to eat, but they have a way of taking many things which it is not safe to poison. They can be discouraged by dusting the plants with slaked lime—perfumed with coal oil by stirring in enough for strong perfume without making the lime too wet for dusting. Other powdery insecticides, like carbolated lime, tobacco dust, etc., also accomplish this purpose. They can sometimes be driven away by smoke from fires on the windward side. They can be shaken early in the morning from tall plants onto a catching sheet. We know of no easy way with them.

Flea Beetles and Darkling Beetles.—These two small pests are not closely related but we group them on the basis of their chief work which is to attack young seedlings or transplants and knock them out before they have a fair show in the world. The flea beetle is not much larger than a flea and is usually first seen as a flea is apt to be when it is on the jump. Its function is to corrugate the leaf surface and perforate the leaf and cause its quick collapse. The "darkling" beetle is a slim, black pest about a quarter of an inch in length which attacks the plants just at or below the ground surface. Its specialty in gardening is tomato plants and it is largely averted by wrapping the plant in a piece of newspaper when setting out, as described on page 273. W. S. Booth, of Mountain View, protected his transplants of tomatoes with notable success against both flea and darkling beetles in this way:

> I mixed neutral arsenate of lead with water at the rate of one pound to thirty gallons of water. I recommend mixing about ten gallons at a time to keep the solution clean. This amount would be enough for about 3,000 plants. Frequent stirring is necessary, as lead arsenate does not dissolve much better than fine sand. Taking thirty to fifty plants in a bunch, I dipped the tops clear to the roots in the solution just before taking them to the field. Following this treatment, I did not lose one-half of one per cent of my plants

from insects, while another grower who had several acres near by had to replant more than one-half of his ground.

These pests can also be checked by thoroughly dusting the plants with arsenate of lead powder, already described in this chapter; or with Paris green thoroughly mixed with flour at the rate of one ounce to the pound.

Squash Bugs.—These are the disagreeable black insects which take to the squash family and are commonly known as "stink bugs." They cannot be poisoned because they suck juices and do not eat the leaf surface on which the poison is spread. The young insects can be killed by spraying with kerosene emulsion, but the old ones are hard to get by any process except hand-picking and smashing. One should always be on the lookout for this pest and pounce quickly on the first appearance and the masses of dark brown eggs which they deposit on the leaves and stems of the plants they infest, and stamp out the trouble by hand-picking. Various growers have reported some success with a spray of creolin (a tablespoonful to a gallon of water) also with powdering the vine and nearby ground with tobacco dust, also with a powder made by stirring enough kerosene oil into air-slaked lime as already noted for diabroticas. They can be trapped under pieces of board, etc., placed near to the plants and can be crushed early in the morning. Unless one starts in very early the pest is very hard to control but it is fortunately not very abundant. All garden rubbish should be cleaned up in the fall for it is in such shelter that the insects hibernate. Such cleaning up and springtime watchfulness are the most promising recourses.

Hills of plants can be protected from early attack by stink bugs by covering with cloth, paper, etc. One way is thus: Make arches of baling wire big enough so that by the time a paper laid over the arch would be in the way of the growing vines, the vines would be big enough to escape damage. Put such an arch over each hill and cover it with a square of thin, tough wrapping paper which you will have dipped into high grade distillate or heavy kerosene. Lay the paper cornerwise on the arch and fasten the corners down with dirt. It will allow light to pass through and will keep off any migrating bugs.

The Potato Worm.—This serious pest is mentioned on page 246 as the third of the great potato destroyers. It is commonly first noticed by the burrows in the tuber which separate from the flesh after cooking in black strings. Their work also inpairs the external appearance of the fresh tubers. The worm is the offspring of a small gray moth which lays its eggs in early and again in late summer on potato foliage or stems or on the stems of other plants, mostly of the potato family, or on exposed tubers in the field or in the storeroom. As the eggs hatch, the caterpillars either mine the stems and leaves, rarely pushing down in case of loose soil several inches and may enter potatoes which are not exposed. Their burrows in the tubers ruin them and permit of further destruction in field or cellar, as more moths are bred to lay more eggs. There may be three, possibly four, broods in a season. In addition to the suggestion given on page 246 the following protective details may be noted:

Plant as deep as practicable (5 to 6 inches), except in winter planting where much rain is expected and the ground likely to be too wet; in that case ridge or hill-up to keep tubers well covered.

Harvest as early as possible, before the potato tops become so dry as to drive the partially grown larvæ to descend and work on the tuber.

In harvesting the sacks should never be covered with potato tops, as the larvæ leave these when they wilt and enter the potatoes. The sacks should be sewed as soon as possible and hauled from the field, and dug potatoes should never be left in the field or exposed to the moth over night. All cull potatoes should be gathered up within two weeks and either fed to stock at once or destroyed.

White Fly.—This is a small winged insect, floury white, which has a great liking for beans, but may take to many other vegetables. It attacks the underside of the leaves which first turn yellow in spots and finally all over, and then fall as the insects draw the juices from them. Whenever the plant is touched they rise up almost like smoke and then settle back. They can be killed with kerosene emulsion, properly made without injury to plants. You need a good pump and nozzle to make a spray-cloud to dislodge them from the under sides of the leaves and entangle them in air also.

Other Pests.—The gardener will, of course, encounter many other pests, but he must not be dismayed. The treatment will usually be indicated by the character of the injury inflicted, as suggested earlier in this chapter, and by the ways of working and fighting the chief pests which we have particularized. Specific pests are also mentioned in the preceding cultural chapters: on beans, page 141; on cabbage, page 164; on corn, page 187; on potatoes, page 246.

Whenever insects do not yield to the treatments proposed, or whenever the use of these remedies does not seem to be practicable, it is well for the grower to apply to Agricultural Experiment Station, University of California, Berkeley, sending a specimen of the insect and of its work if possible. An answer embodying the latest information on the subject, will be made without cost to the applicant. Useful descriptive publications will also be sent in many cases.

INJURIOUS FUNGI.

Molds, mildews and blights seem to be ever on the alert to attack garden plants whenever suitable conditions prevail. Fortunately. California is much less subject to these intrusions than countries with humid summer heat, and some very destructive garden fungi either do not occur here or occasion very little trouble. Still it is well for the gardener to know that the arrest of fungous invasion is a very much simpler proposition than it was some years ago. This fact is due to the demonstration of the efficacy of solutions of copper salts. The most effective preparation is known as the Bordeaux mixture, which is prepared as follows:

> Dissolve one-half pound copper sulphate (bluestone) in two and one-half gallons of water in a wooden pail, slake one-half pound fresh lime in one-half gallon of hot water, stirring and rubbing till completely slaked; when the lime is cool put the bluestone solution into a five-gallon oil can, and add the lime by allowing it to run through a coarse cloth strained to remove lumps or dirt. Stir in water enough to fill the can and it is ready for use. The mixture should not stand in a metal vessel.

This makes a light blue whitewash which will be effective as it slowly diffuses its components over the leaf surface. In our dry summer it remains operative for a long time. It does, however, make the plant unhandsome, and where a fungicide is desired which does not discolor the leaves, the following may be substituted for the Bordeau mixture:

> Dissolve three-fourths ounce of copper sulphate (bluestone) in one quart of warm water, and one ounce of salsoda (washing soda) in another quart of warm water. When both are cool, mix them together and add five ounces of washing ammonia. When the mixture is clear, after standing long enough to accomplish that, add cold water to make five gallons.

This preparation is much shorter in its protective effect than when the copper is progressively set free from the lime as in the Bordeaux mixtures.

Obviously these copper compounds cannot be applied to foliage which is the edible part of the vegetable except during the early period of its growth.

Some fungi are quite readily checked by the use of dry sulphur, but when this is not effective, the copper compounds will be found satisfactory.

In many cases the attacks of fungi may be avoided by keeping the plants growing thriftily, or by choosing varieties which are not affected by the diseases to which other varieties succumb. Wherever this course is open to the gardener, it will be found more satisfactory than the application of remedies.

DESTRUCTIVE ANIMALS AND BIRDS.

Against the larger marauders from the forest, the field or the barnyard, the farm garden must be protected by an adequate fence close enough to exclude fowls and jack-rabbits. For the latter purpose closely set strands of barbed wire are the cheapest material. The bottom wire must be set low enough to prevent entrance by scratching under. Even when a neater fence is made of wire netting, strands of barbed wire above and below are often very useful. The method of making such fencing is described on page 86.

A good rabbit-proof fence can be built with chicken wire netting two feet wide, stapled to the inside of the posts, the bottom of it at the ground surface and barbed wire with bars 2½ inches apart run along just above the ground surface to prevent tunneling under, with another barbed wire stapled to the other side of the post just above the upper line of the fence to prevent jumping over. If you can get barbs 2½ inches apart, you can make a good rabbit fence by excluding the netting and running the wires about 3 inches apart until you come to 2 feet and 6 inches apart above that. Then keep a greyhound and a shot gun for the rabbits which may manage to get through in some way.

In a small garden rabbits can be fooled by a straw cover. Mr. H. C. Tracy, of Hollywood, gives this interesting experience:

> In my garden bounded on two sides by brush, having on previous occasions had no luck with poisons and deterrents, I tried spreading over all my plantings a light scattering of straw—by no means enough to darken the seedlings but quite sufficient to screen them from rabbit-brained marauders, who seemed to regard the whole field as a straw patch. A corner which I neglected was eaten to the ground, but where my ruse was first tried out I now have beans with pods six inches long, their tops, of course, showing plainly above the straw, but remaining unmolested.

Squirrels.—Ground squirrels should be destroyed in the adjoining fields as well as in the garden, or its protection is almost a hopeless undertaking. When the ground is wet, squirrels are very satisfactorily destroyed with carbon bisulphide, and this material, with appliances and instructions for its use, can usually be had in country stores.

In dry soil the carbon bisulphide is not as effective, and some of the many good squirrel poisons must be used. The following has been shown to be very satisfactory:

> Strychnine, one ounce; cyanide of potassium, one and one-half ounces; eggs, one dozen; honey, one pint; vinegar one and one-half pints; wheat or barley, thirty pounds. Dissolve the strychnine in the vinegar, pulverizing it in the vinegar, or it will gather in a lump. See that it is all dissolved. Dissolve the cyanide of potassium in a little water. Beat the eggs. Mix all the ingredients together thoroughly before adding to the barley. Let it stand twenty-four hours, mixing often. Spread to dry before using, as it will mold if put away wet.

A cheaper and exceedingly effective poison is that invented by Mr. S. E. Piper of the U. S. Department of Agriculture as follows:

Whole barley (recleaned)	14 lbs.
Strychnine sulphate	1 ounce
Soda (bicarbonate)	1 ounce
Saccharine	1 dram
Thin starch paste	1 pint
Corn starch (Karo or equal)	2 ounces

Dissolve the strychnine in hot water; thicken with starch to about the consistency of thin soup. Dissolve the soda in one-half pint of hot water and add a little at a time to the poisoned starch until effervescence ceases, then add the syrup and saccharine, mix well and apply to the grain, stirring constantly until the poison is evenly distributed throughout, and the grain is thoroughly dry.

Each quart of the poisoned grain is sufficient for 40 to 50 baits. This quantity scattered along squirrel trails or runs but not close to the holes, will not endanger the stock but will kill poultry.

Trapping Gophers.—Some gardeners are very successful in gopher trapping. It is an art which has to be learned by experience and patient observation. The following suggestions are made by an expert and they may be helpful to beginners:

Gophers come to the surface in the night and generally close their holes in the morning soon after daybreak. They frequently emerge again about noon, and a third time late in the afternoon. It is best to set the trap in an open hole, as the gopher will be sure to return to fill it. Still the holes may be opened if the dirt is still fresh, with a good prospect of the gopher's return. Therefore the trapper may make his rounds three times a day, as above indicated.

In the second place, care should be exercised in preparing the hole for the insertion of the trap. The trapper should assure himself that he has found a straight hole for a distance of at least ten inches, with no lateral branches, otherwise the gopher in pushing out the dirt will likely enough thrust the trap to one side, cover it up or spring it without being exposed to its grasp.

In the third place the trapper should be supplied with at least two varieties of traps—one for the larger gophers and the other for the smaller ones. The common iron gopher trap, which springs downward, is excellent for the former, and the small wire trap, which springs upward, is generally successful with the latter. It is taken for granted that the size of the hole is indicative of the size of the gopher. Either trap should be inserted nearly its full length into the hole, pressed down firmly, and a little dirt piled at the outer end to prevent its being easily pushed out. After the trap is set it is well to cover the opening with some grass or weeds. Sometimes the holes require a little enlarging, but care should be taken to make the fit as close as possible, that the body of the gopher may be kept near the center, and thus more exposed to the prongs of the trap.

In the fourth place, the trapper should be supplied with a small spade and a little gouge-shaped implement for trimming the hole.

Finally the trapper should be supplied with traps as numerous as the extent of the pest demands. He should not be discouraged by lack of success at first. Perseverance is as essential in this work as in any other, and will generally win. We have in mind the successful capture of a big gopher after trapping for him a week, changing the trap two or three times a day; he had then destroyed about fifty hills of corn.

Poisoning Gophers.—Poisoning is an easier method of destroying gophers, and it is very satisfactory if faithfully done. The The poison is strychnine in crystal form, which can be pulverized in the small bottle in which it is bought by using the head of a nail. Take out a very small amount on the tip of a knife blade and insert it into raisins, or pieces of carrot, potato, alfalfa stems, or almost any succulent vegetable substance which is handy at the time. Find where the gopher has been at work last, and remove the loose earth from the surface, to find where it has come from; then dig down to find the main runway, generally from six to twelve inches. The runway being found, clean out any dirt that may have dropped into it, and place the poison a little distance from the opening. Then seal up the hole with a lump of earth or sod, being careful that none drops in on the poison, and put the dirt back as it was before. The gopher will soon return to his labor, and will seldom fail to pick up the bait.

Another way to get into the burrow without disturbing the mounds is to sharpen a broom stick and push it into the earth about a foot back of the mound until it shows the runway by dropping into it. Drop in the poison and cover the hole you have made with dirt.

It is often useless to put poison in holes left open by gophers when at work, as they shove the poison out with the dirt, and it becomes lost. If the hole is opened and poison is placed therein it should be closed up again, as the gopher, seeing the light and feeling the air where it was not intended, goes to work to remedy that evil by showing a load of dirt against the opening, thereby covering up or throwing out the bait.

For large scale work in poisoning gophers, this recipe is very effective:

Sweet potatoes, parsnips, or carrots	8 quarts
Flour paste	½ pint
Strychnine alkaloid, powdered	¼ ounce
Saccharine	1/16 ounce

Chop the vegetables, or cut them with a knife, into one-half inch cubes. Make a thin paste of flour and water and boil for a few minutes. Stir the strychnine and saccharine into one-half pint of the cooked paste and pour it over the chopped vegetables, stirring until each piece is coated. Two or three of these cubes are to be dropped in each runway. The alkaloid form of strychnine should be used in preference to the sulphate, as the former is but slightly soluble in water and remains largely on the outside of the bait, leaving the center sweet. The saccharine is used to disguise partially the bitterness of the strychnine.

Sometimes the same poisoned grain used for squirrels can be successfully used for gophers by placing it in the runways as first described.

The Mole.—The mole is an insect-eater and as such is beneficial, but he destroys so many plants while mining for grubs and worms, that a gardener can well dispense with his services. The best way to do this is to watch for the rising soil and striking in just behind the mole with a spade or shovel throw him out and finish him. When he is working in the lawn or where the ground is too hard for this treatment, strike into the moving earth with a hatchet. It generally reaches the animal, and we have killed more moles in this way than in any other.

CHAPTER XXXIX.

WEEDS IN CALIFORNIA.

For fear that a book on gardening without a chapter on weeds might prove too great a shock to horticultural propriety, this concession is made to conventionality. The fact is that the California gardener gives himself less concern about weeds than the distant reader can perhaps realize. There are several reasons for this.

First: It is possible to get quite clean ground for winter gardening by weed-killing cultivation before planting. This is one advantage of our long planting season.

Second: Winter gardening is free from many weeds which only grow in high temperatures.

Third: Owing to the long spring season it is possible to clean with hand tools or with plow and cultivators, the land which is to be planted after frosts are over.

Fourth: Summer growth of weeds is largely prevented by the dry surface layer of the soil and those which do start are destroyed by the persistent summer cultivation which is essential to the preservation of moisture for the crop.

Fifth: Many of the worst weeds of humid climates cannot survive our dry summer in uncultivated soil and are thus prevented from becoming serious pests here because of their own natural limitations.

And yet we do have weeds, magnificent weeds, weeds which reflect the growth-giving resources of our soil and climate quite as strikingly as do our useful plants. Mustard, turnip and radish extend laterals for the birds of the air to rest upon. Smartweed grows in some places too high for a man to look over; in other places morning-glory, licorice, Bermuda and Johnson grasses have a grip upon the soil which is almost impossible to loosen. Jimson, dog-fennel and others, numerous beyond mention, are found in varying amounts everywhere; but for the season stated above they do not give the gardener such grievance against fate as their names might suggest. On the other hand, Canada thistle and burdock are almost unknown, while pusley and quack grass have in some places assumed quite an air of respectability as forage plants.

Naturally weeds are worst in soils which are moist in summer, such as the rich lowlands, and on such lands the California vegetable grower has to fight for his crop. Some winter-grown plants, like onions and various roots are secured at the cost of much weeding in some situations. Still it is true, as remarked above, that weeds do not, taking the state as a whole, call for such an amount of expensive effort as they occasion in humid climates, and if the garden is arranged, as it should be, for the free use of horse-power, the burden of hand pulling and hoeing is reduced to a minimum, and the exertion of a prolonged hand-to-hand contest with weeds is seldom heard of in California.

For these reasons, perhaps, California has no special contributions to make to general knowledge of weed killing. So far, however, as her experience goes it is most strenuously in favor of destroying weeds as robbers of moisture which must be saved for useful plants. The California garden must be clean and the surface must be frequently stirred, whether weeds appear or not. It may be fortunate, then, that we are not altogether free from weeds, for their invitation to slaughter accomplishes far more for the garden than their own destruction.

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